INSTRUCTIONS AND
PARTS BREAKDOWN

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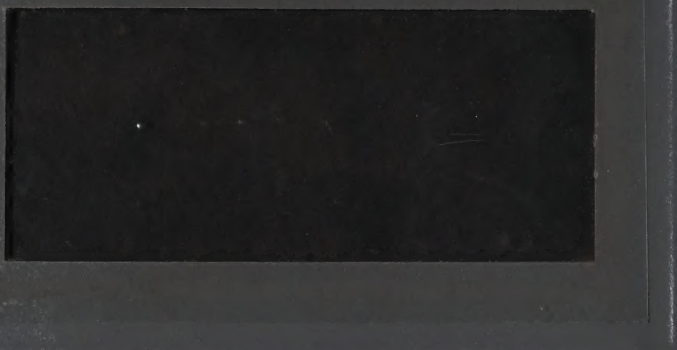
(Radiation, Inc.)



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TECHNICAL MANUAL

INSTRUCTIONS AND PARTS BREAKDOWN

TELEGRAPHIC DISTORTION MEASUREMENT AND MONITORING SYSTEM (TDMS)

MODEL R.2

(RADIATION)

(6625-446-1993; 6625-446-1992; 6625-730-8520; 6625-730-8513; 6625-897-7809; 6625-703-3171; 6625-730-8514)

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SECTION I
USE AND MAINTENANCE

1. GENERAL INFORMATION

a. Purpose of Manual

This instruction manual contains instructions for the installation, operation and maintenance of the Telegraphic Distortion Measurement and Monitoring System (TDMS), Figures 1-1, 1-2 and 1-3.

b. TDMS Equipment

Component	Model No.	Federal Stock No.
Transmitter	TDMS 5EB-R.2	6625-446-1993
Coder	14-106A	
Coder Adapter	14-105	
Receiver	TDMS 6EB-R.2	6625-446-1992
Tel-A-Scan	14-200B	6625-730-8520
Rack-Mount Power Supply	14-102/103D	6625-730-8513
Test Cable	14-107A	
High Voltage Receptacle Protective Covers	9037-465	
Power Plug Adapter	9037-465	

Accessories	Model No.	Federal Stock No.
Portable Power Supply	14-104B	6625-897-7809
Power Plug Adapter	9037-470	
Relay Test Adapter	14-101	6625-703-3171
TDMS Utility Cart	14-300A	6625-476-0557

c. System Functional Description

The complete TDMS is designed to transmit "perfect" (less than one percent distortion) telegraph test signals at modulation rates of 20 to 160 bauds. On command it will transmit up to 50 percent distortion in predetermined, controllable increments with a minimum accuracy of one percent; or it will measure the amount of distortion already present in incoming telegraph signals with one percent accuracy. The system also tests start-stop mechanisms, including the regenerative repeaters, and permits definite visual signal analysis by circular and spiral displays on the Receiver, or linear CRT displays on the Tel-A-Scan. The Tel-A-Scan CRT indicates and directly measures signal voltages. These functions may be accomplished without interrupting the flow of traffic. In addition, the Transmitter tests and permits adjustment of telegraph relays under simulated operating conditions.

"Baud" is the unit of signal modulation rate. It is the reciprocal of time duration in seconds of the shortest element (either mark or space) within a code signal. If this shortest element were repeated continuously for one second, the number of times it occurred would be the modulation rate in bauds. Thus, a signal whose shortest element is 20 milliseconds has a modulation rate of 50 bauds. For conversion of bauds to words per minute, and vice-versa, refer to Figure 1-4.

d. TDMS 5EB-R.2 Transmitter

(1) Functions

The TDMS Transmitter (Figures 1-5, 1-6, 1-7 and 1-8) generates perfect (less than one percent distortion) signals within the speed range of 20 to 160 bauds, or signals with up to 50 percent start-element distortion. The code transmitted consists of a start element, five character elements, one, one and one-half, or two stop elements. Any telegraph character can be continuously repeated, or a 100-character test message can be transmitted. The unit also transmits continuous 1:1 or 2:2 reversals, or a steady mark or steady space signal. On command the Transmitter induces any selected or continuously variable amount of distortion up to 50 percent with an accuracy of one percent, aiding in ascertaining the exact degree of distortion that any system or teleprinter can tolerate before garbling.

In the receiving mode the Transmitter detects and measures the degree of various types of distortion. Its monitoring input circuits accept neutral and polar grounded or ungrounded input signals.

(2) Distortion Measurement

Distortion of either test transmissions generated by the instrument itself or automatic telegraph signals from an external source can be measured, providing the length of each character is an integral multiple of one-half unit. Start-stop receiving mechanisms, including regenerative repeaters, can be tested and telegraph relays can be checked for bias and transit time.

Transitions are displayed on the cathode-ray tube in the form of bright dots on a circular trace. The scale over the face of the CRT is divided into 50 equal angular divisions. The position of the dot on the scale furnishes distortion measurement to within one percent. In the absence of distortion all dots are superimposed. The circular sweep is twice the speed of the telegraph signal.

(3) Relay Testing

For relay testing, bias is indicated by the angular displacement between two bright dots. Transit time is indicated by the length of a bright arc on the circular trace. Contact bounce shows as a series of dots following the transit-time arc.

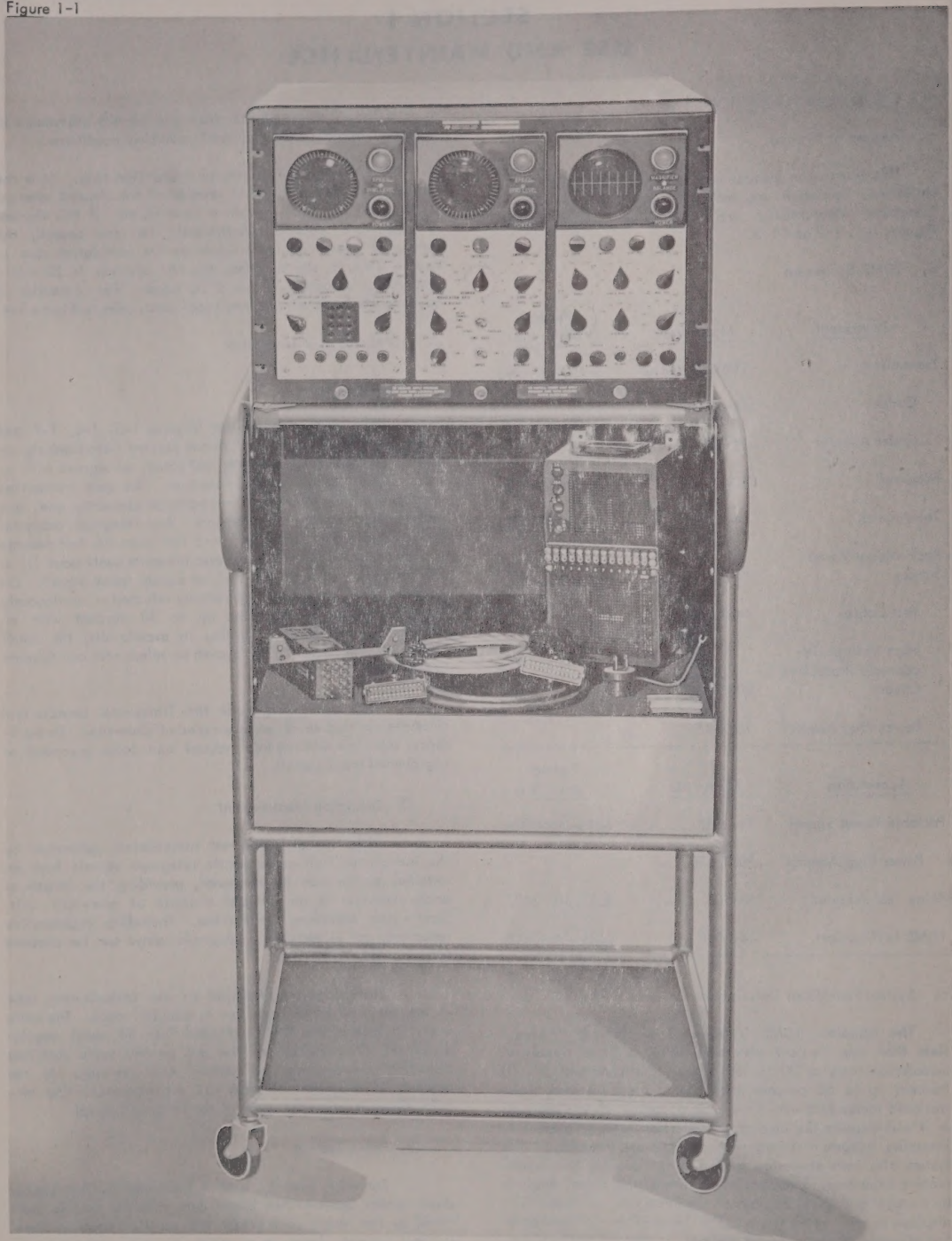

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Figure 1-1. Complete TDMS With Accessories

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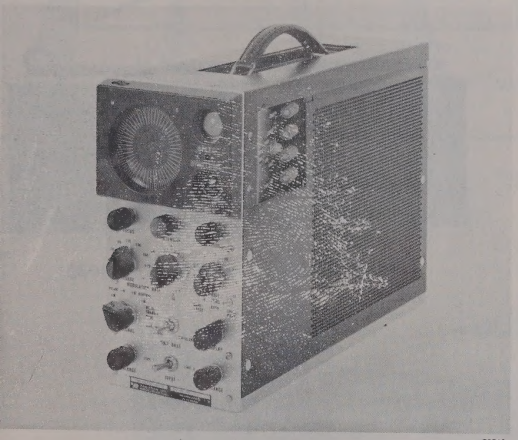
TDMS 5EB-R.2 TRANSMITTER



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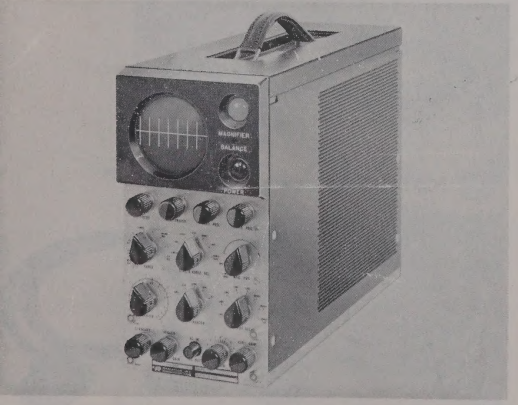
TDMS 6EB-R.2 RECEIVER



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TDMS MODEL 14-200B TEL-A-SCAN

Figure 1-2. Major TDMS Units

(4) Transmission

The Transmitter output circuitry employs a Western Union Type 202A relay. The terminals provided allow connection to either neutral or polar systems (Figures 1-9 and 1-10).

(5) Relay Test Circuit

Facilities for testing telegraph relays are provided by a front panel connector which accommodates the Western Union 202A relay. Model 14-101 Relay-Test Adapter accepts the Western Electric Model 255A, Western Union 203, 204, Sigma Model 72, or Magnetic Devices 300-2 relays.

(6) Relay Testing, Transit Time and Bias

The relay can be tested at speeds from 20 to 160 bauds. The Transmitter CRT displays transit time. The circular sweep revolves two revolutions per baud at the preset relay operating baud rate. The trace is brightened during open-contact periods.

The display for bias-free relay adjustment is also shown on the Transmitter's CRT display; two bright dots appear on the CRT which, when superimposed, indicate bias-free relay operation. Since there are two revolutions of the time base for each complete cycle of relay operation, a bias of one percent produces an angular separation of 7.2 degrees between the two dots. Thus, the relay can be adjusted with a high degree of accuracy.

(7) Distortion Measurements on Operating Telegraph Lines

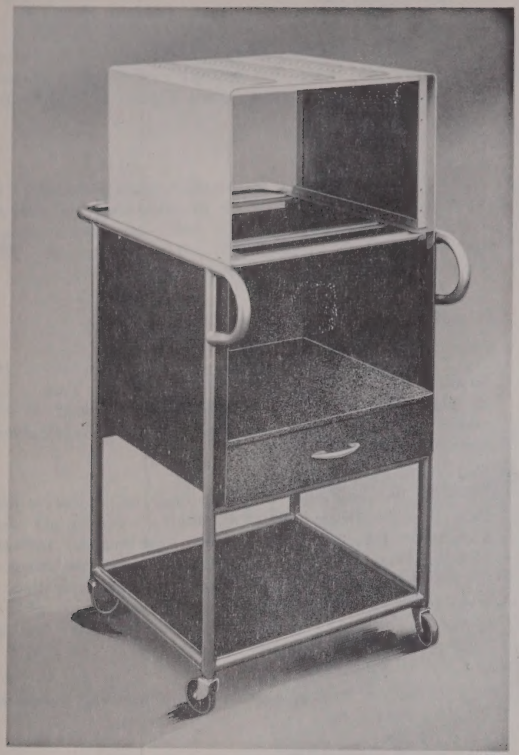
INPUT 1 to the distortion measurement portion of the Transmitter allows an impedance choice of either 220,000 or 270 ohms, selectable by the IMPEDANCE switch. INPUT 2 provides high impedance only.

Distortion is displayed on the circular trace, which has a sweep rate of one-half the time of the baud rate at which the system is being operated. Each space-to-mark and mark-to-space transition appears as a bright dot on the circular trace. If the Transmitter is properly adjusted the dots will appear permanently positioned. The speed of operation of the telegraph line being tested may then be read directly from the RANGE and VERNIER controls on the front panel. The percentage of distortion is indicated on the CRT graticule by the angular displacement of the dots with respect to each other. If a perfect, distortion-free signal is being received, all the dots will be superimposed and appear as one.

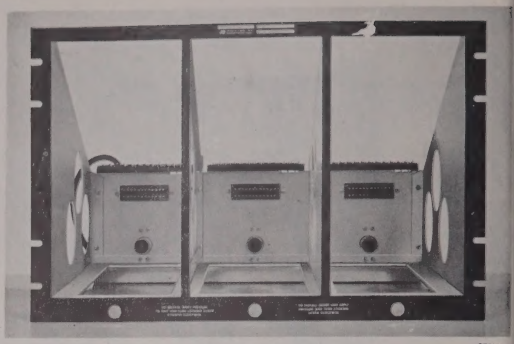
e. TDMS 6EB-R.2 Receiver

(1) Functions

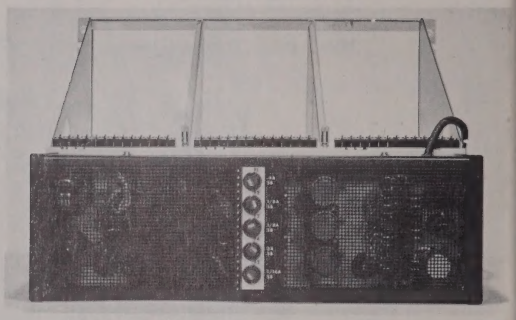
The TDMS Receiver (Figures 1-11, 1-12, and 1-13) measures the distortion of each element of any character at any point on an operating start-stop automatic telegraph circuit. It also measures the total distortion of synchronous telegraph or low-speed data transmission systems and the transmission speed in bauds. Additionally, the Receiver tests telegraph relays for bias and transit time.



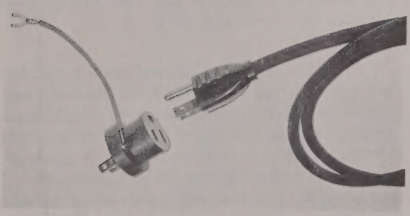
TDMS UTILITY CART 14-300A



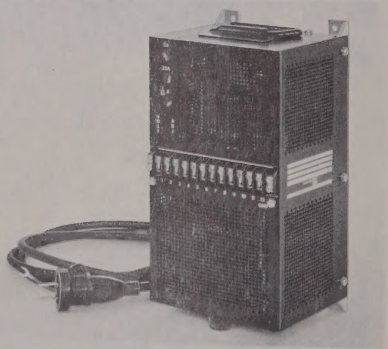
RACK MOUNT 14-102



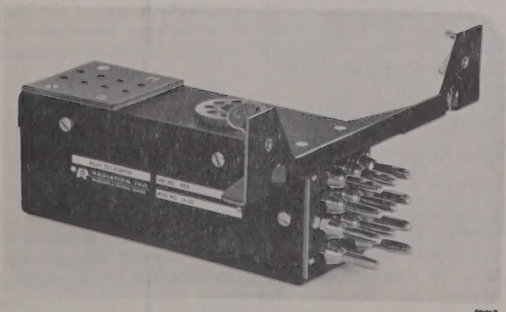
RACK-MOUNT POWER SUPPLY 14-103D



POWER PLUG ADAPTER



PORTABLE POWER SUPPLY 1401048



RELAY TEST ADAPTER 14-101

CODER ADAPTER 14-105

TEST CABLE 14-107A

Figure 1-3. Auxiliary TDMS Components

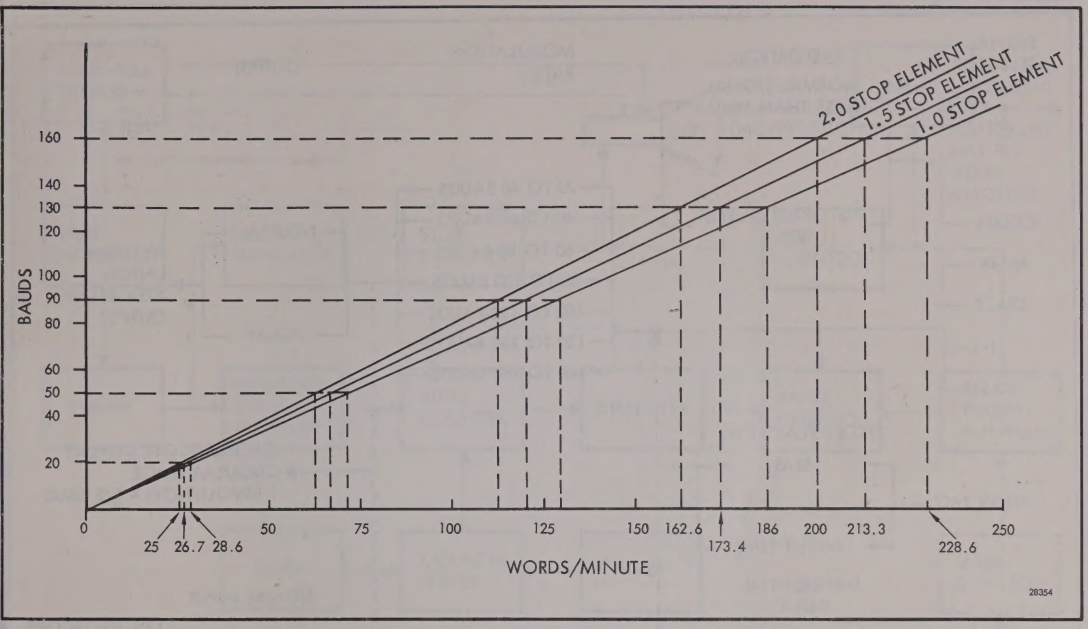


Figure 1-4. Baud Conversion Chart.

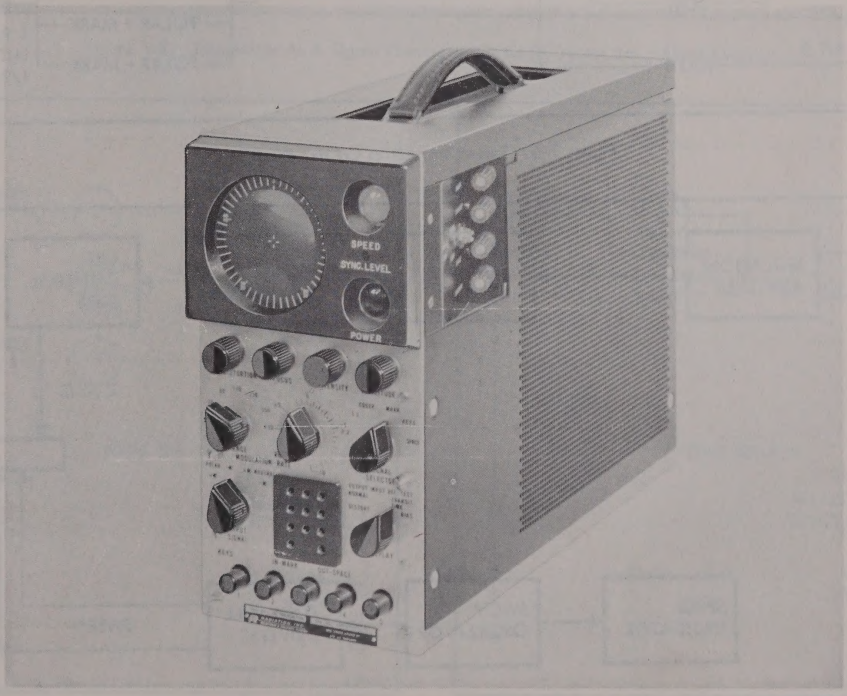


Figure 1-5. TDMS 5EB-R.2B Transmitter

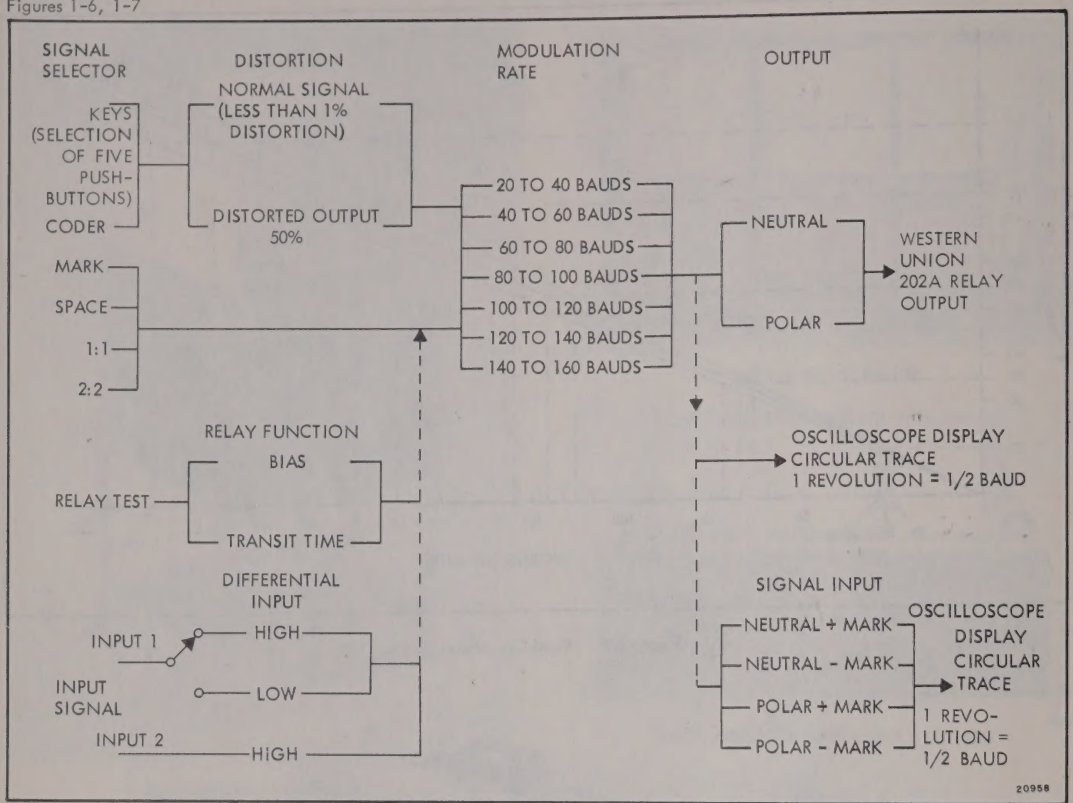


Figure 1-6. Transmitter Series Control Diagram

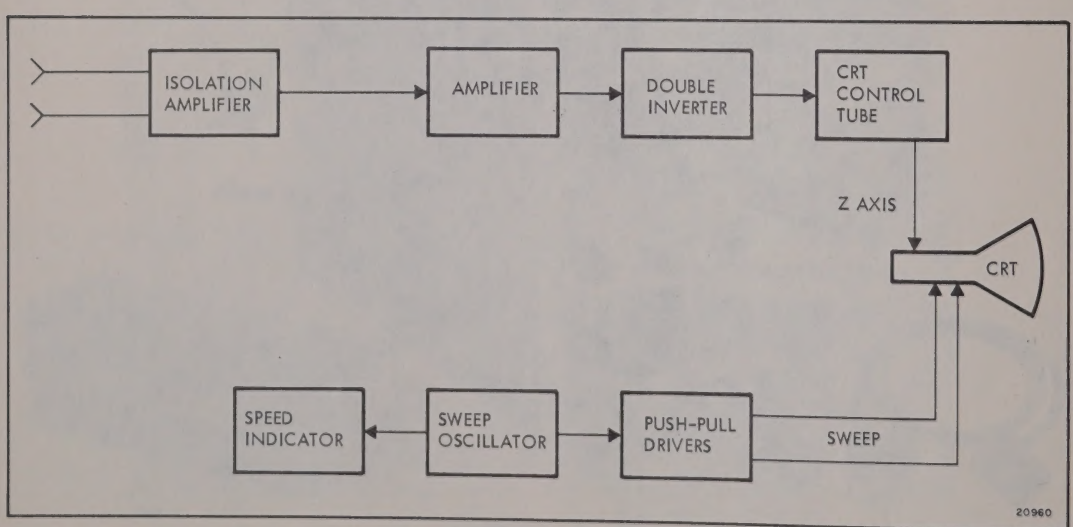


Figure 1-7. Transmitter In Receiving Mode - Block Diagram

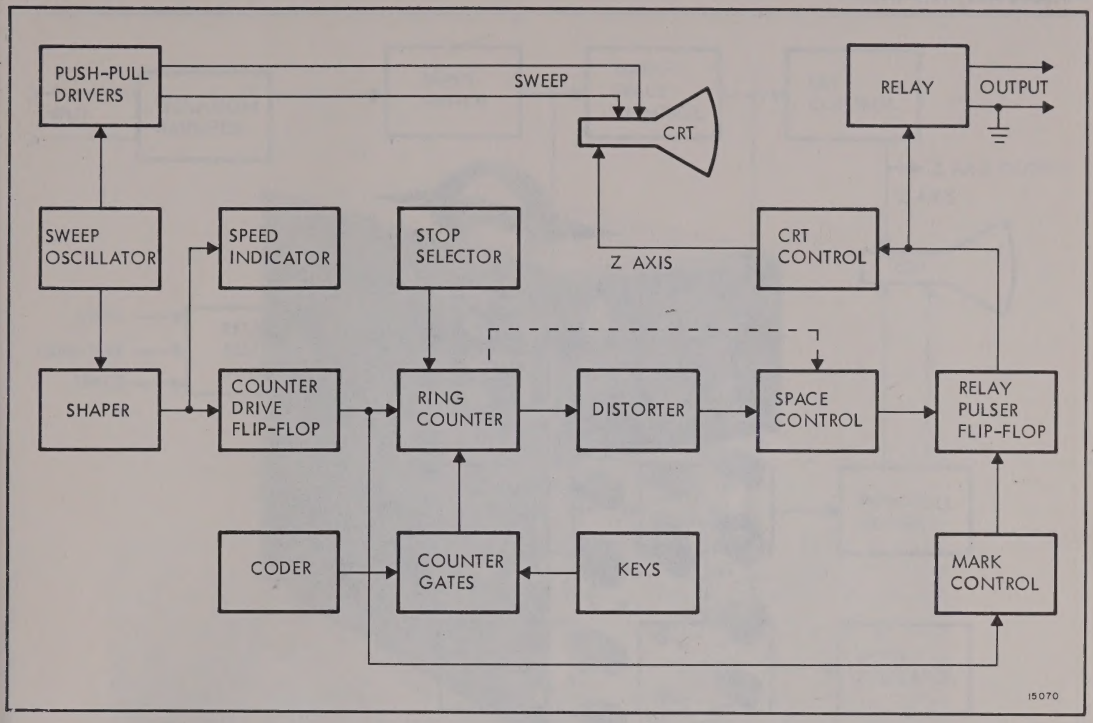


Figure 1-8. Transmitter As A Signal Generator Or Code Transmitter - Block Diagram

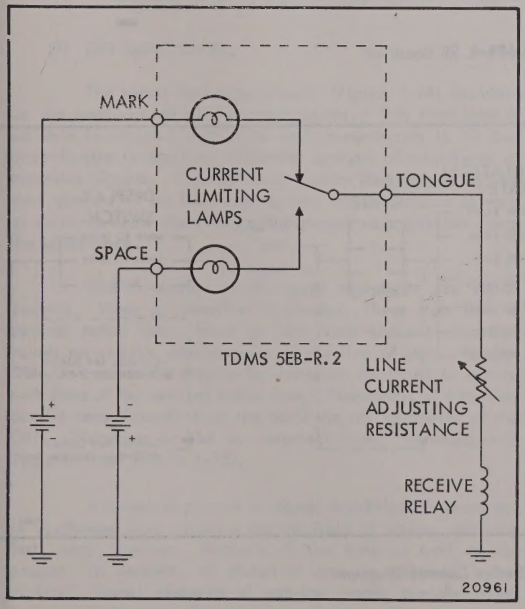


Figure 1-9. Typical Polar Connections - Transmitter

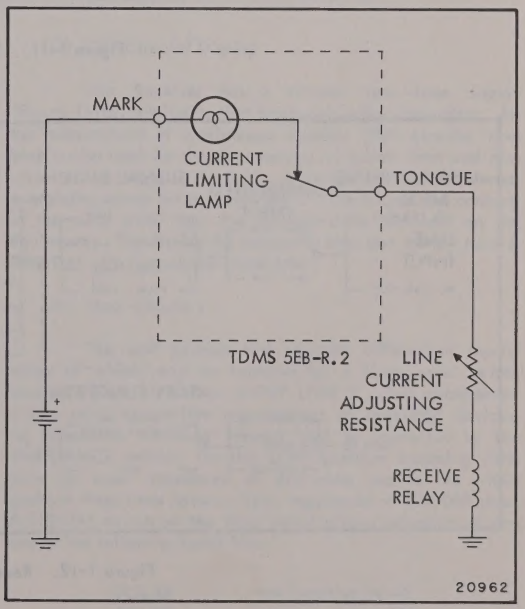


Figure 1-10. Typical Neutral Connections - Transmitter

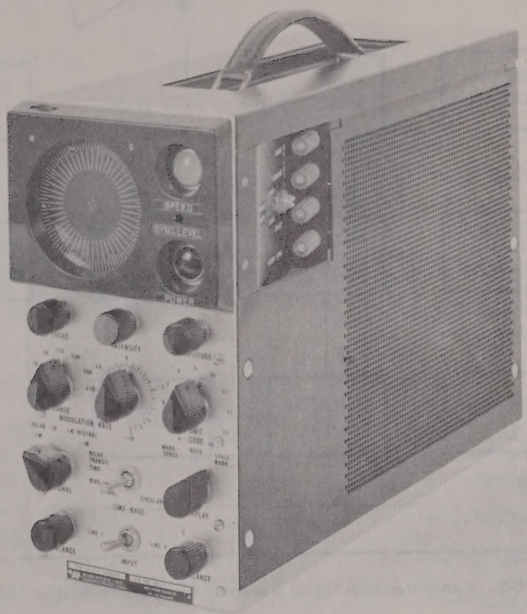


Figure 1-11. TDMS 6EB-R.2B Receiver

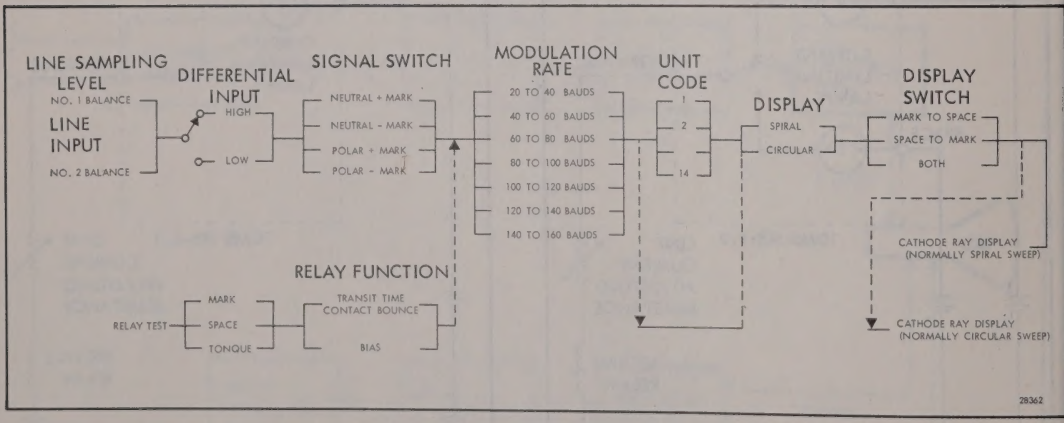


Figure 1-12. Receiver Series Control Diagram

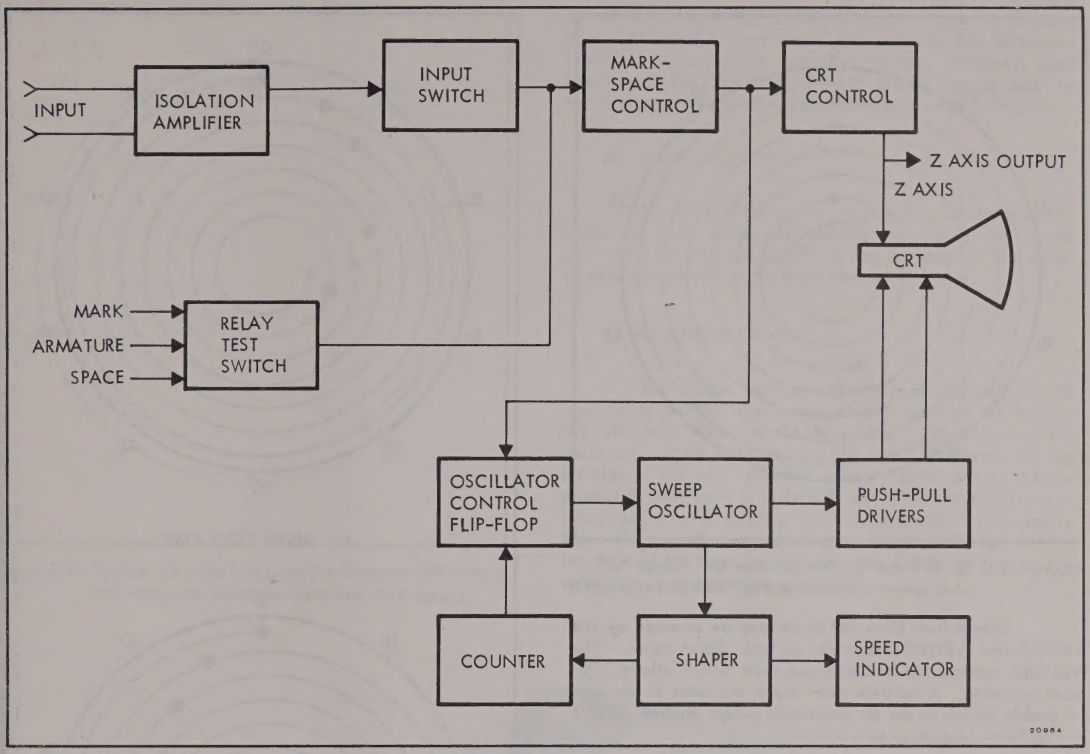


Figure 1-13. Receiver - Simplified Block Diagram

(2) CRT Spiral Display

The spiral time-base display (Figure 1-14) provides for the measurement of start-stop signals. This time base is variable in duration from three and three-fourths to 13 and three-fourths revolutions, allowing analysis of most types of start-stop signals. The start-stop display is triggered by the start element of an incoming signal; mark-to-space as well as space-to-mark transitions are displayed as bright dots along the spiral trace.

One revolution of this spiral represents one signal element. When no distortion is present, these dots form a vertical radial line. Short or long start-element distortion causes an angular displacement of the line of dots. Random distortion causes the dots to be unevenly displaced to one or both sides of the vertical radial line. Percentage of distortion can be read directly from the scale on the perimeter of the CRT. Distortion caused by incorrect speed transmission is also displayed (Figure 1-15).

A complete picture of signal conditions is presented in condensed form within a narrow field of vision, allowing fast, easy viewing: Analysis of the type as well as the amount (in percent) of distortion can be obtained immediately. Signal elements of varying length are displayed; speed variations are detected immediately. The trace conforms with, and is synchronized by, start-stop signals (i.e., the trace starts with the signal start element).

(3) CRT Circular Display

The Receiver has a circular time-base display (Figure 1-16), similar to that employed in the Transmitter, for the measurement of synchronous signals. This circular time base is also used for the measurement of transit time and bias when testing relays. The testing of relays requires an external energizing source for the relay coil. The tongue and contacts of the relay under test are connected to terminals on the equipment. The display for measuring bias and transit time is identical with that of the Transmitter.

(4) Input Circuitry

The unit accepts two separate differential inputs, either of which may be selected by a front panel switch marked INPUT LINE 1 or INPUT LINE 2. This arrangement allows rapid comparison measurement of start-stop devices. An impedance matching network unit is controlled by the IMPEDANCE switch. In the LOW position incoming lines have an input impedance of 270 ohms and in the HIGH position these lines have an input impedance of 220,000 ohms. A SIGNAL switch on the front panel allows selection of any one of the following conditions:

POLAR	+M (positive mark)
POLAR	-M (negative mark)
NEUTRAL	+M (positive mark)
NEUTRAL	-M (negative mark)

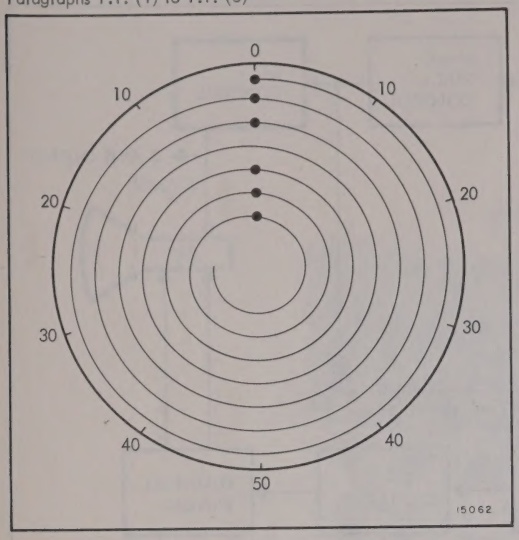


Figure 1-14. Spiral Trace On The Receiver CRT (Letter "D" when speed is correct and no distortion is present)

Speeds from 20 to 160 bauds may be selected by the RANGE and VERNIER controls on the front panel. The VERNIER control has a calibrated scale which allows ±10-baud variation. A built-in neon speed indicator is provided to enable speeds to be set accurately when strobed with a tuning fork of the required frequency.

f. TDMS Model 14-200B Tel-A-Scan

(1) Functions

The Tel-A-Scan (Figures 1-17, 1-18, and 1-19) is a special purpose oscilloscope designed for automatic telegraph and low-speed data system evaluation. (It is also highly versatile and useful in performing general purpose testing and check-out functions.) When used for telegraphic test, this unit monitors on-line telegraph signals (without interrupting the flow of message traffic), performs telegraph waveform analysis, and acts as an on-line voltmeter.

(2) Vertical Input

An eight-position INPUT SEL switch on the front panel provides for the selection of any one of five inputs differentially connected to the vertical amplifiers. The three remaining positions allow two front-panel jacks to be connected to the vertical amplifiers as follows: INPUT 1 connected to the matching vertical amplifier with INPUT 2 open and the matching amplifier grounded; INPUT 2 connected to the matching vertical amplifier with INPUT 1 open and the matching amplifier grounded; INPUT 1 and INPUT 2 differentially connected to the vertical amplifiers.

(3) Vertical Amplifier

The vertical amplifier is flat within three db through 100 kc; this permits rise-time displays of better than 4.0 microseconds.

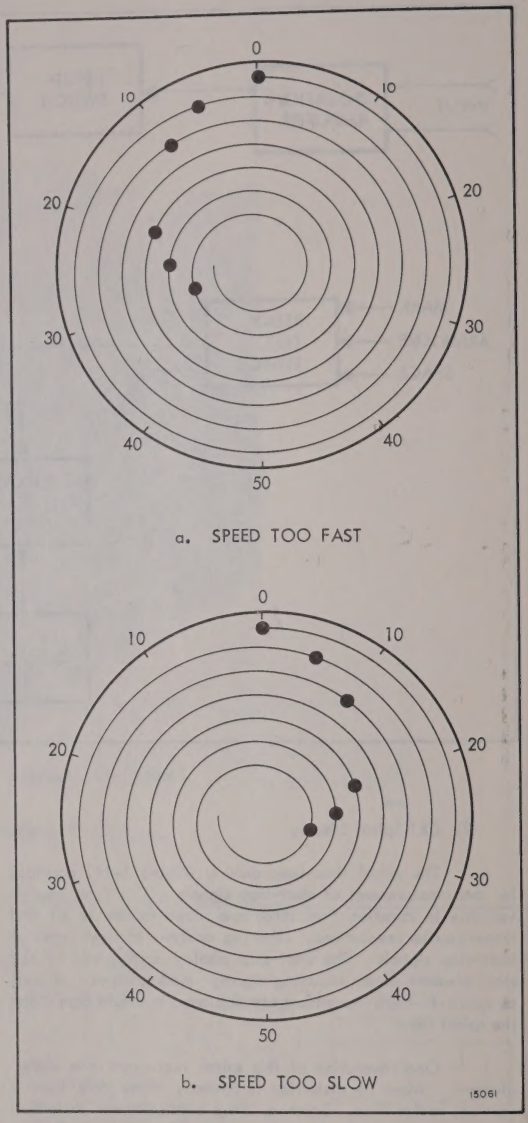


Figure 1-15. Indications of Incorrect Speed

(4) Sweep Circuit

A modified phantastron sweep provides triggered linear sweeps in 10 continuously variable ranges from 30 microseconds to 3 seconds.

(5) Synchronizing and Horizontal Amplifier Circuit

The SYNC & HORIZ SEL switch provides for the selection of positive (+) or negative (-) INT, EXT, and 60-cycle synchronization. An EXT SYNC terminal is available on the rear of the power supply as well as on the front panel.

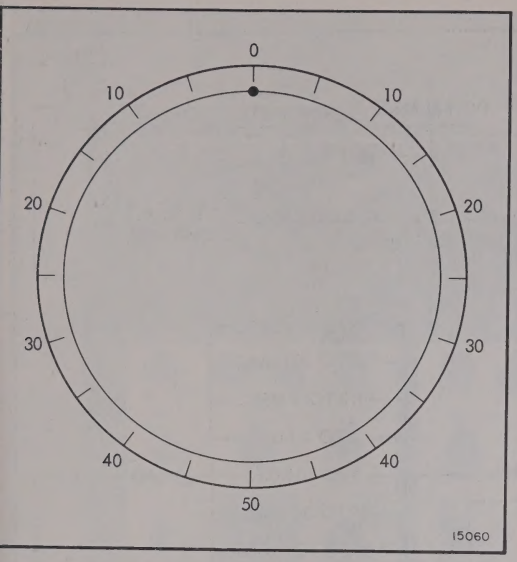


Figure 1-16. Typical Circular Trace On The Receiver CRT (Single stationary dot indicates distortion-free signal)

In addition, the HORIZ GAIN position of this switch connects the HORIZ INPUT front panel connector to the horizontal amplifier, allowing the operation of the horizontal gain function of the TRIGGER - HORIZ GAIN control and the connection of the horizontal amplifier to an external source.

(6) Sweep Magnifier

The MAG POS control provides a sweep magnification of eight times and permits the time base to be positioned for enlarged viewing of any increment of the signal waveform displayed on the oscilloscope.

(7) Calibration Circuit

The unique voltage calibration circuit allows the operator to position the retrace at any point on the face of the CRT tube with the CALIB control. The CALIB control scale will, when multiplied by the factor indicated by the position of the ATTENUATOR switch, reveal actual voltage present at that point. Therefore, evaluation of amplitudes of interfering noise or voltages from incoming circuitry can easily be attained. When not required, the retrace is removed from the face of the tube by rotating the CALIB switch to the extreme counterclockwise position.

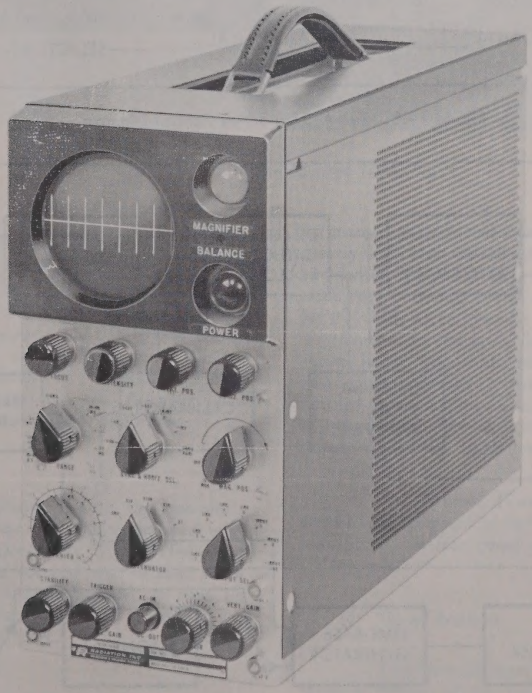


Figure 1-17. TDMS Model 14-2008 Tel-A-Scan

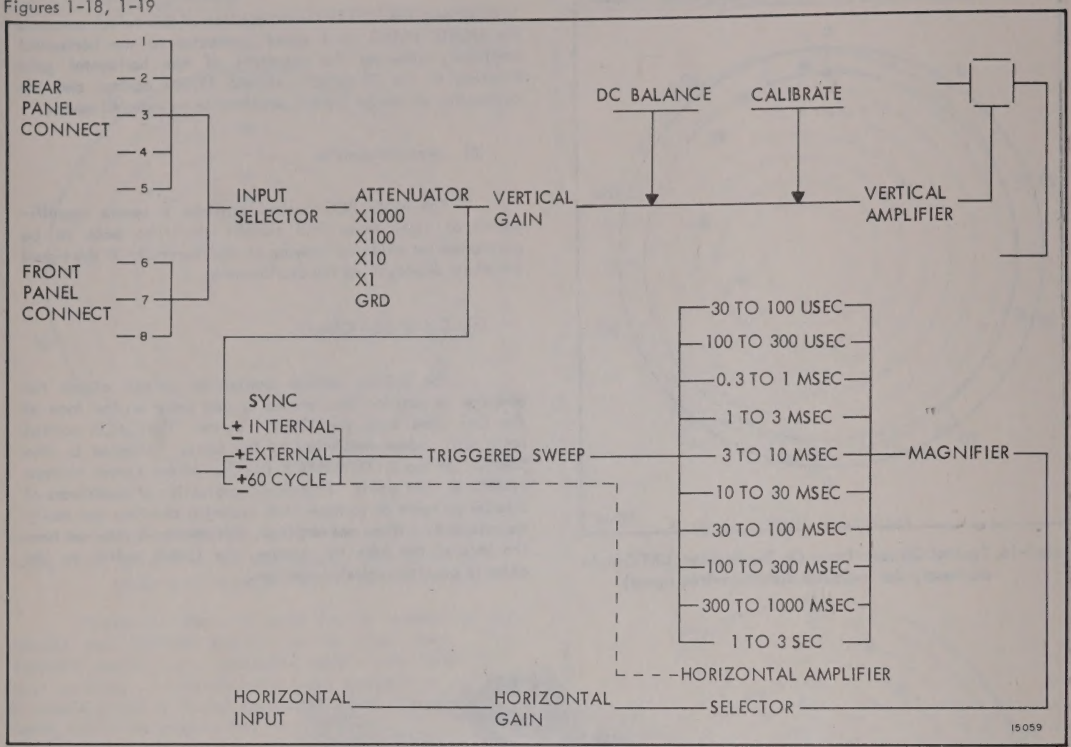


Figure 1-18. Tel-A-Scan Series Control Diagram

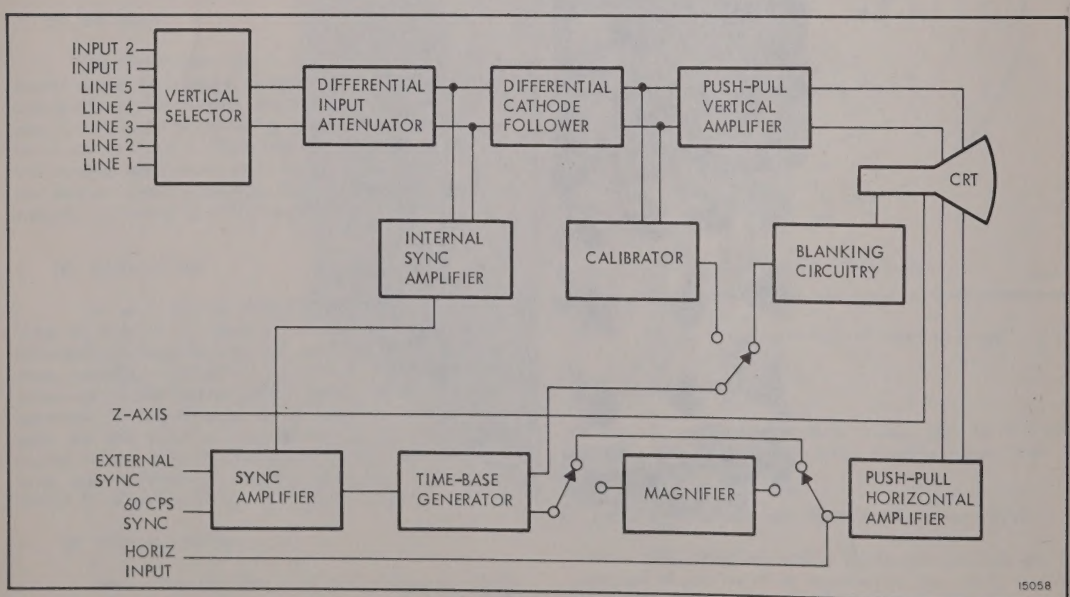


Figure 1-19. Tel-A-Scan - Simplified Block Diagram

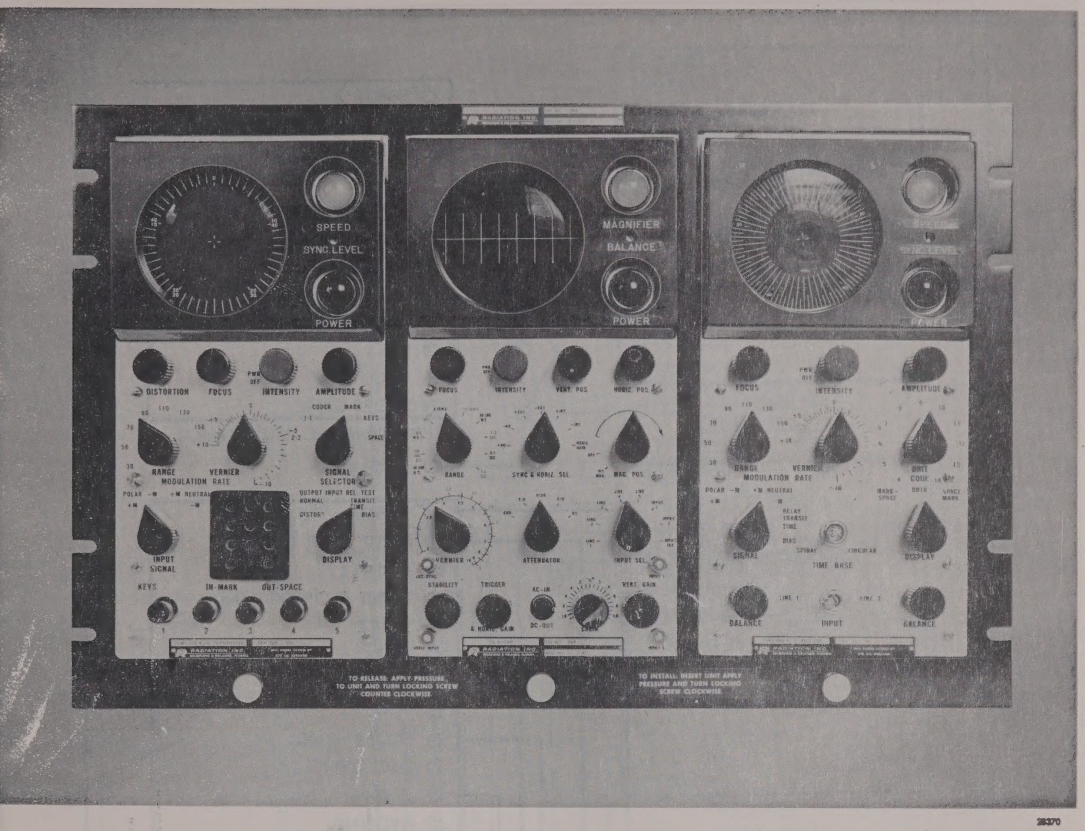


Figure 1-20. Rack-Mounted TDMS Set

g. System Applications

(1) General

This section describes TDMS applications to telegraphic and data transmission systems and details the use of the equipment in the testing and monitoring of various telegraph subsystems and components. The coordinated displays presented simultaneously by the Receiver and Tel-A-Scan CRTs are illustrated and briefly interpreted.

(2) Interconnection

For most TDMS applications it is to the operator's advantage to have a Tel-A-Scan unit interconnected with the Receiver and Transmitter (Figure 1-20). If the Tel-A-Scan unit is not available, a good oscilloscope may be used when connected as shown in Figure 1-21; however, it must be reconnected for each new analysis.

(3) Power Supplies

The Rack-Mount Power Supply Model 14-102/103D with its three accessory compartments is normally supplied with the complete TDMS. Each compartment has a twelve-connector barrier strip which permits any unit to be installed in any compartment. Identifying information on the rear of each unit clearly indicates the proper barrier strip terminals for interconnection (Figure 1-22). Once the interconnections are made each unit must utilize the compartment originally wired for it. Units wired into the desired circuitry are released by rotating the knurled knob (located on the front of the Rack-Mount Power Supply immediately beneath each unit) one-half turn counterclockwise. An ejection spring moves the unit forward three inches, allowing its removal. The unit is re-installed by inserting it in its compartment and turning the release mechanism clockwise.

The Portable Power Supply Model 14-104 has a barrier strip identical to that of the Rack-Mount Power Supply installed on its rear panel and which provides all necessary connections.

(4) Signal Analysis

Simultaneous analysis of signals displayed by the receiver portion of the Transmitter and Tel-A-Scan, or the Receiver and Tel-A-Scan, is accomplished by properly positioning the front panel controls in accordance with the input connections. A linear presentation of the Transmitter output may also be selected by proper positioning of the

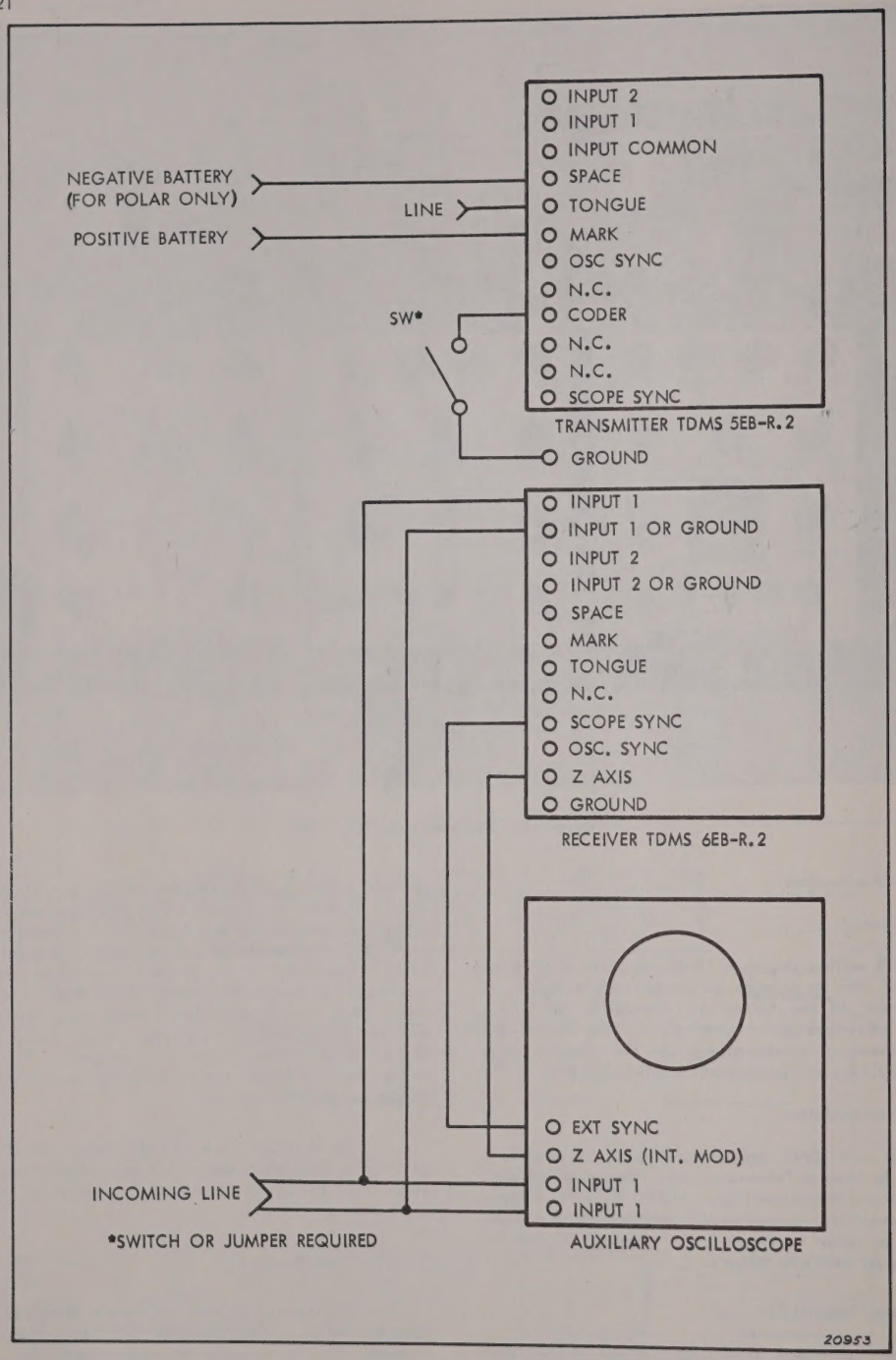


Figure 1-21. Portable TDMS Configuration With Auxiliary Oscilloscope

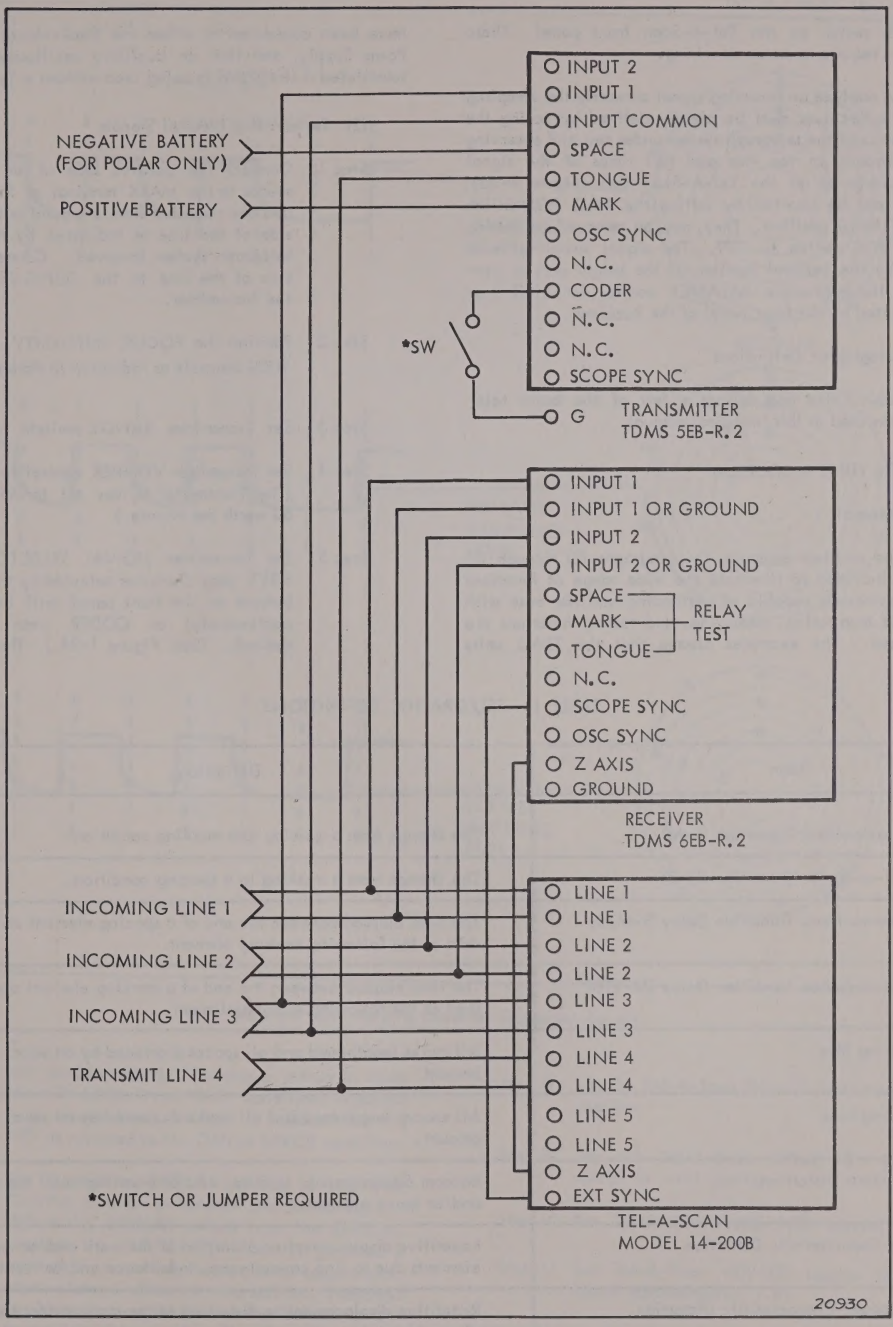


Figure 1-22. Normal Rack-Mount Power Supply Interconnections

INPUT SEL switch on the Tel-A-Scan front panel. These connections require no external wiring.

To analyze an incoming signal correctly the sampling level of the Receiver must be clearly defined by noting the characteristics of the telegraph system under test and observing the dots present on the rise and fall times of the signal elements displayed on the Tel-A-Scan CRT (Figure 1-23). These dots can be inserted by setting the MAG POS switch in the INT MOD position. They may be removed by setting the MAG POS switch to OFF. The signal sampling level indicated by the vertical position of the bright dots is controlled by the applicable BALANCE control for LINE 1 or LINE 2 located on the front panel of the Receiver.

(5) Telegraphic Definitions

Table I lists and defines a few of the basic telegraphic terms used in this technical manual.

h. Specific TDMS Applications

(1) General

The problem examples in paragraphs (2) through (5) below are included to illustrate the wide range of functions which the system is capable of performing and the ease with which these monitoring, measuring, and testing functions are accomplished. The examples assume that the TDMS units have been connected to either the Rack-Mount or Portable Power Supply, and that an auxiliary oscilloscope has been substituted if the TDMS is being used without a Tel-A-Scan.

(2) Transmitting Neutral Signals

Step 1 Connect the positive side of an external dc source to the MARK terminal of the Transmitter and the negative side to ground or to the "cold" side of the line as indicated by the automatic telegraph system involved. Connect the "hot" side of the line to the TONGUE terminal of the Transmitter.

Step 2 Position the FOCUS, INTENSITY, and AMPLITUDE controls as indicated in Paragraph 4.a.(1).

Step 3 Set Transmitter RANGE switch to 50 bauds.

Step 4 Set Transmitter VERNIER control to -4.5 bauds. (The Transmitter is now set to 45.5 bauds, or 60 words per minute.)

Step 5 Set Transmitter SIGNAL SELECTOR switch to KEYS (any character selected by the five pushbuttons on the front panel will be transmitted continuously) or CODER (test message) as desired. (See Figure 1-24.) The pushbuttons

TABLE I. TELEGRAPHIC DEFINITIONS

Term	Definition
Space-to-Mark Transition (S-M)	The change from a spacing to a marking condition.
Mark-to-Space Transition (M-S)	The change from a marking to a spacing condition.
Space-to-Mark Transition Delay (S-MTD)	The time elapsed between the end of a spacing element and the start of the following marking element.
Mark-to-Space Transition Delay (M-STD)	The time elapsed between the end of a marking element and the start of the following spacing element.
Marking Bias	All marks lengthened and all spaces shortened by an equal amount.
Spacing Bias	All spaces lengthened and all marks shortened by an equal amount.
Fortuitous Distortion	Random displacement; splitting and/or breaking up of the mark and/or space elements.
Line Characteristic Distortion	Repetitive displacement or distortion of the mark and/or space elements due to line capacitance, inductance and/or resistance.
Equipment Characteristic Distortion	Repetitive displacement or distortion of the mark and/or space elements due to equipment malfunctions.
Cyclic Distortion	A distortion similar to characteristic, fortuitous, or bias, but of a periodic nature.
Total Distortion	The cumulative total of all forms of signal distortion.

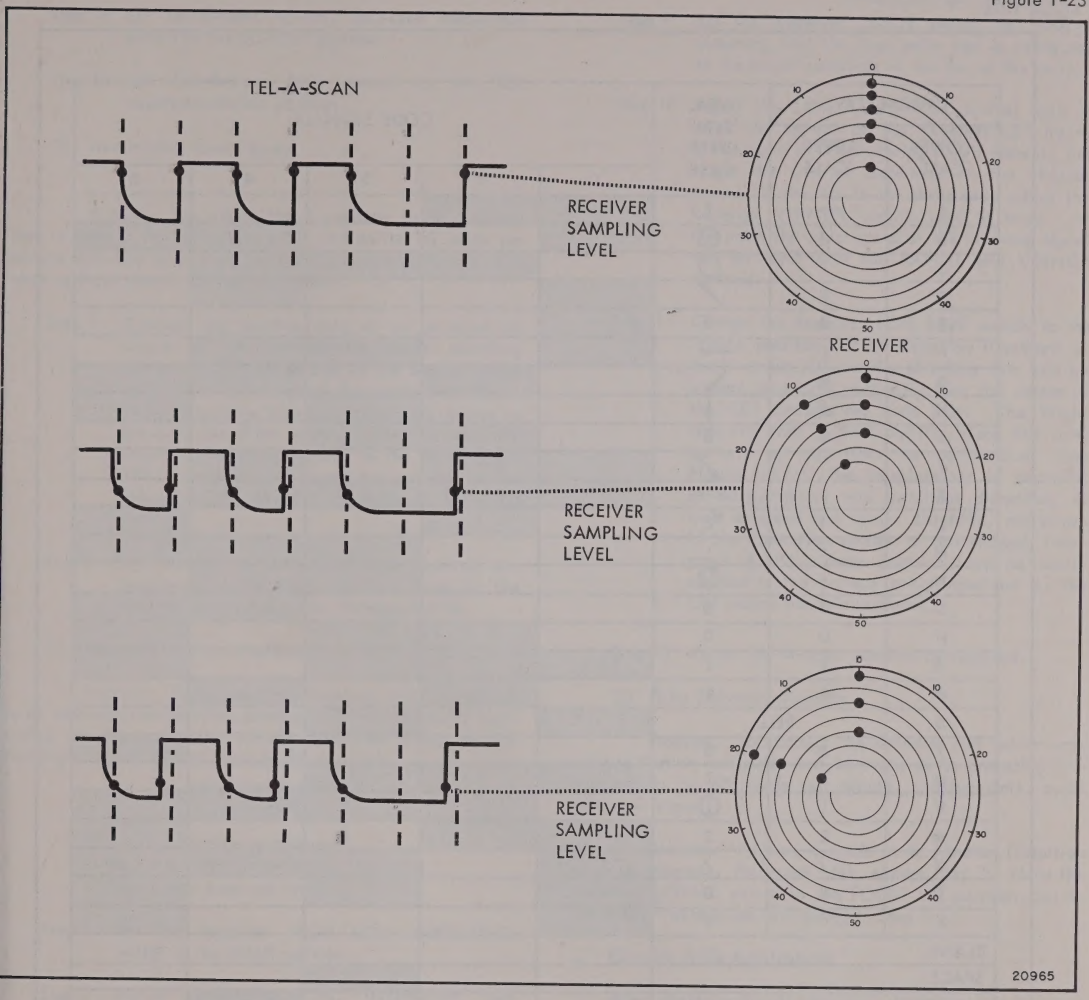


Figure 1-23. Varying Receiver Triggering Levels

are double-acting: Pushing a button in locks the KEY in the IN or MARK condition; if pushed in a second time, the lock is released and the KEY is returned to the OUT or SPACE condition.

Step 6 Set Transmitter DISPLAY switch to NORMAL OUTPUT in order to transmit undistorted signals. (When the DISPLAY switch is in the DISTORT position the DISTORTION control provides a method of controlling the amount of long or short start-element distortion transmitted, indicated in percentage on the face of the Transmitter CRT by a bright dot.)

Step 7 Set Tel-A-Scan FOCUS, INTENSITY, STABILITY, TRIGGER and positioning controls (VERT POS and HORIZ POS) as indicated in Paragraph 4.a.(3).

Step 8 Set the Tel-A-Scan RANGE switch to 0.1-0.3 position.

Step 9 Set the Tel-A-Scan SYNC & HORIZ SEL switch to -INT position.

Step 10 Set Tel-A-Scan MAG POS control to OFF.

Step 11 Set Tel-A-Scan VERNIER control to stop the signal (approximately 1.6).

Step 12 Set Tel-A-Scan ATTENUATOR switch and VERT GAIN control to the positions which give approximately one inch deflection on the Tel-A-Scan CRT.

Step 13 Set Tel-A-Scan INPUT SEL switch to LINE 4.

CHARACTERS		WEA. SYM.	CODE SIGNALS				
LOWER CASE	UPPER CASE	UPPER CASE	1	2	3	4	5
A	—	↑	■	■			
B	?	⊕	■			■	■
C	:	○		■	■	■	
D	$	↗	■			■	
E	3	3	■				
F	!	→	■		■	■	■
G	&	↘		■		■	■
H	£	↓			■		
I	8	8		■	■		
J	'	↙	■	■		■	
K	(	←	■	■	■	■	
L	)	↖		■			■
M	.	.			■	■	■
N	,	ⓝ			■	■	
O	9	9				■	■
P	0	0		■	■		■
Q	1	1	■	■	■		■
R	4	4		■		■	
S	BELL		■		■		
T	5	5					■
U	7	7	■	■	■		
V	;	ⓥ		■	■	■	■
W	2	2	■	■			■
X	/	/	■		■	■	■
Y	6	6	■		■		■
Z	"	+	■				■
BLANK		—					
SPACE					■		
CAR. RET.						■	
LINE FEED				■			
FIGURES			■	■		■	■
LETTERS			■	■	■	■	■
			1	2	3	4	5

■ = KEY IN

□ = KEY OUT

TO TRANSMIT THE LETTER "A" CONTINUOUSLY PUSH FIRST TWO KEYS.

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Figure 1-24. Teletype Code Chart

Step 14 Set Tel-A-Scan AC-IN, DC-OUT pushbutton switch to the DC-OUT position.

Step 15 Set Tel-A-Scan CAL control to the full counterclockwise position.

(3) Transmitting Polar Signals

Problem: To connect the Transmitter to an outgoing line in order to transmit distorted or undistorted 60 words per minute start-stop polar positive-mark telegraph signals, and to observe those signals on the Tel-A-Scan.

Step 1 Connect the positive side of an external dc source to the Transmitter's MARK terminal; connect the negative side of the source to the cold side of the telegraph line under test. Connect the positive side of a second dc source to the cold side of the telegraph line; connect the negative side of the source to the Transmitter's SPACE terminal. Connect the hot side of the telegraph line to the Transmitter's TONGUE terminal.

Step 2 All Transmitter and Tel-A-Scan controls are positioned in the same manner as those in the neutral - transmit solution, Paragraph h (2).

(4) Neutral Distortion Analysis

Problem: To connect the Receiver and Tel-A-Scan to an incoming line carrying constant traffic, reportedly consisting of 60 words per minute, positive-mark, neutral telegraph signals and to analyze its condition.

CAUTION

Do not connect to the traffic line until Step 1 has been performed.

Step 1 Set the Receiver HIGH/LOW IMPEDANCE switch to the HIGH position.

Step 2 Adjust Receiver FOCUS, INTENSITY, and AMPLITUDE controls as indicated in Paragraph 4.a.(2).

Step 3 Place the Receiver RANGE switch in the 50-baud position.

Step 4 Adjust the Receiver VERNIER control to the -4.5 position. (The Receiver is now set to 45.5 bauds.)

Step 5 Set the Receiver UNIT CODE switch to the "7" position.

Step 6 Place the Receiver SIGNAL switch in the NEUTRAL +M position.

Step 7 Place the Receiver TIME BASE switch in the CIRCULAR position.

Step 8 Set the Receiver DISPLAY switch in the BOTH position.

Step 9 Set the Receiver INPUT switch to 'INE 1 (assuming that the line under test is connected to the proper terminals on the rear of the unit).

Step 10 Adjust the LINE 1 BALANCE control until a bright dot appears on the Receiver CRT trace. If the speed of the incoming line is correct, the bright dot will be stationary on the circular trace. If the dot is not stationary, adjust the Receiver VERNIER control until it stops. At this point the exact speed of the incoming signal can be read from the RANGE and VERNIER controls.

Step 11 Change the Receiver TIME BASE switch to the SPIRAL position. If no distortion is present on the incoming line a series of bright dots will be present extending vertically from the center of the CRT through the zero line. The bright dots will vary in their position along this line, but will not vary from the zero radius. (See Figure 1-14.) The complete set of examples of mark, space, and fortuitous distortion, as well as speed and cyclic distortion, are shown in the Operation section of this manual, Paragraph 4.b(9). These patterns can be easily applied to the pattern being observed on the CRT and an analysis rendered.

Step 12 Adjust Tel-A-Scan controls as required.

(5) Polar Distortion Analysis

Problem: To connect the Receiver and Tel-A-Scan units so that an evaluation can be made of an operating line reported to be 60 words per minute, positive-mark, polar telegraph signal.

Solution: Position controls as in Neutral Distortion Analysis example, Paragraph h(4), except Step 7: Place the Receiver SIGNAL switch in the POLAR +M position, not in NEUTRAL +M position as directed in Step 7.

i. Circular Trace Applications

When checking signals other than start-stop, the Receiver can be used for other speed checks by the ratio method (See Figure 1-25). In this mode the oscillator of the Receiver is slaved to an outside source, providing that the RANGE and VERNIER controls are set to correspond to the approximate frequency. Distortion is measured by reading the distance of the CRT (Figure 1-26). If the double-dot method is being used (1:2 ratio) the percentage must be multiplied by two, etc.

2. TABLE OF SPECIFICATIONS

a. TDMS 5EB-R.2 Transmitter

(1) Functional Description

The TDMS 5EB-R.2 Transmitter is primarily a test-signal generator which generates telegraph signals of known characteristics and introduces these signals into operational telegraph systems. These test signals can be transmitted at speeds ranging from 20 to 160 bauds. The Transmitter is also capable of inducing start-element distortion of up to 50 per-

cent into signals transmitted. The degree of distortion can be read from the circular scale on the Cathode-Ray Tube (CRT).

In the receiving mode, the Transmitter detects and measures the degree of some types of distortion. Its monitoring input circuits accept neutral or polar, grounded or ungrounded signals.

(2) Physical Characteristics

Height . . . . . 10-1/2 inches
Depth . . . . . 15 inches
Width . . . . . 5-1/2 inches
Weight . . . . . 15 pounds

(3) Electrical Characteristics

Display: Signals at speeds that are multiples of one-half unit appear on a circular trace on the CRT. Signal transitions appear as bright dots on the circle; in the relay adjustment mode relay bias is indicated by one bright dot for properly adjusted relays, and two dots for improperly adjusted relays. Relay transit time is represented by a bright arc on the circular trace.

Input Measurements: Distortion is seen as separation of the bright dots representing signal element transitions.

Modulation Rate: The RANGE switch provides positions for modulation rates of 30, 50, 70, 90, 110, 130 and 150 bauds. The VERNIER control provides a ±10-baud adjustment on each of the range positions.

Modulation Rate Indicator: A neon lamp is provided which, when strobed with a tuning fork, indicates the speed of the internal oscillator.

Output Signals: Output signals are 1:1, 2:2, 6:1 and 1:6 reversals; continuous mark or continuous space; any character (selected by five pushbutton keys) transmitted continuously; or a 100-character test message, which can be transmitted continuously or on command of the operator.

Distortion Control: Up to 50 percent start-element distortion can be introduced with an accuracy of one percent in transmitted signals.

(4) Equipment Required

Either the Portable Power Supply, Model 14-104B or the Rack-Mount Power Supply, Model 14-102/103D is necessary to furnish all operating voltages to the Transmitter.

Relay Test Adapter Model 14-101 plugs into a receptacle on the transmitter front panel and provides facilities for the testing and simultaneous adjustment of Western Electric 255A, Sigma 72, and Western Union 203 and 204 Relays. Adapters for other relays are available on special order.

(5) Fuses

All fuses for the Transmitter are located in the associated power supply.

(6) Tube Complement

Qty	Type	Reference Number
13	12AU7	V1, V2, V4, V6, V7, V8, V10 through V16
2	12AX7	V3, V5
1	5687	V9
1	3RP1	V17

b. TDMS 6EB-R.2 Receiver

(1) Functional Description

The TDMS 6EB-R.2 Receiver is a special-purpose instrument which enables an operator to monitor and analyze telegraph and low-speed data line systems and to pin-point malfunctions without interrupting the flow of data or message traffic. The unit accepts start-stop synchronous signals of either polarity and provides a cathode-ray tube (CRT) display of the presence and type of distortion and its degree. This display in conjunction with the waveform display on the TDMS Tel-A-Scan (or associated oscilloscope) allows the operator to make an analysis of the distortion.

Individual character-element transitions of start-stop signals are presented on the Receiver spiral trace as dots on different spiral loops; this allows direct measurement of individual element distortion. With a non-distorted signal, all dots form a vertical radial line. Start signals which are long or short displace the dots either to the right or to the left of the vertical line. Bias, characteristic, and fortuitous types of distortion are determined by the relative displacement of the individual dots. Percentages of distortion in two-percent increments are read from the circular scale engraved on the CRT graticule. Synchronous signals are also displayed on the circular trace.

Additionally, the Receiver has limited facilities for measuring the transit time, bias, and contact bounce of polar relays and similar mechanisms. Its Z-axis output causes a dot to appear on the Tel-A-Scan trace at the point on the waveform where the Receiver is being triggered. Simultaneously, distortion observations and analysis can be made by means of the Receiver CRT display.

(2) Physical Characteristics

Height . . . . . 10-1/2 inches
Depth . . . . . 15 inches
Width . . . . . 5-1/2 inches
Weight . . . . . 13 pounds

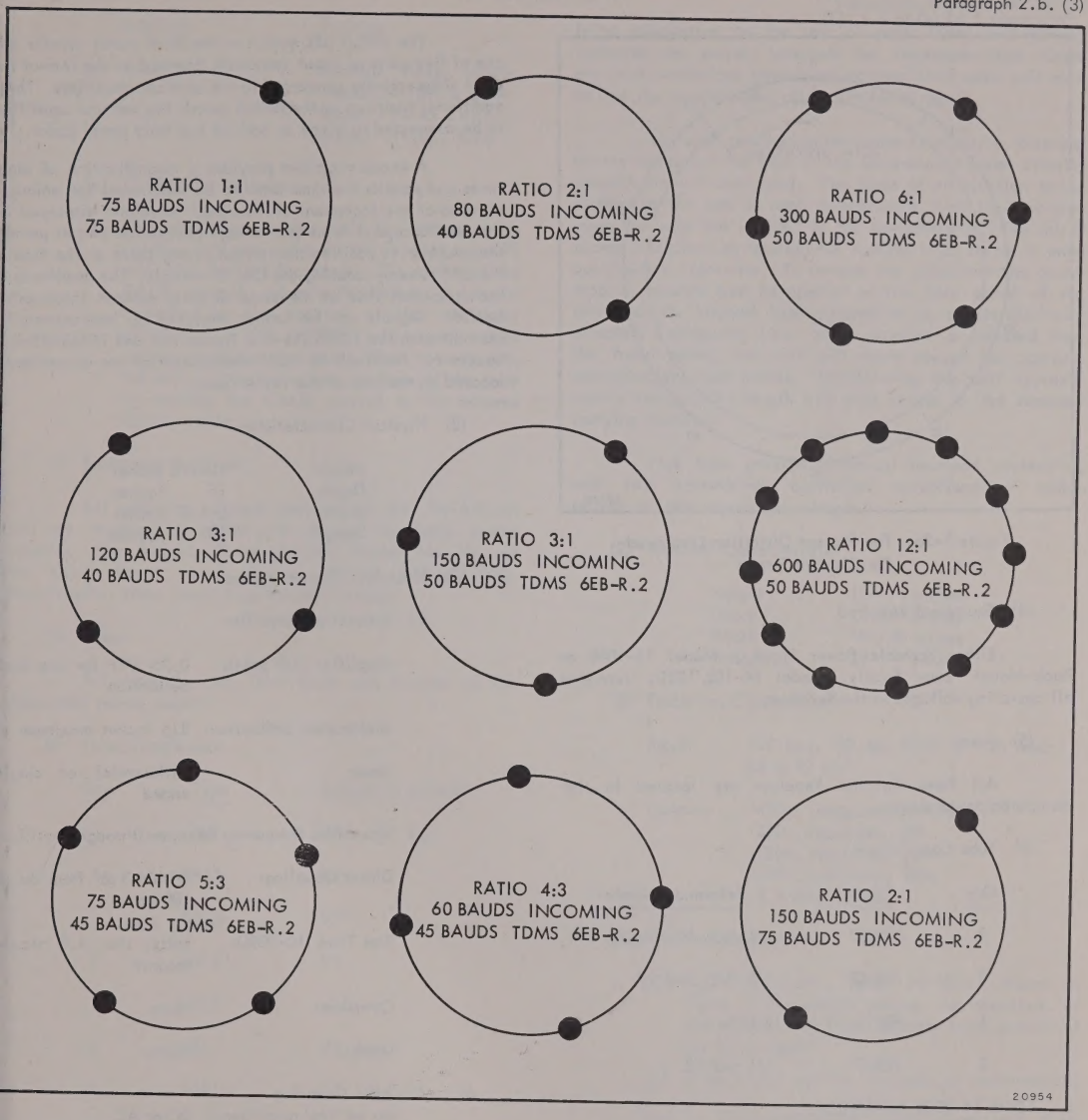


Figure 1-25. Displays For Speed Calibration And Measurement Purposes

(3) Electrical Characteristics

Inputs: Accepts: synchronous or start-stop signals of 4 to 14 elements; low or high impedance; polar or neutral, of positive or negative mark polarity; externally - pulsed relay input; sync input.

Outputs: Synchronization and Z-axis for associated oscilloscope.

Displays: Circular trace for synchronous inputs and relay checking; spiral trace for start-stop inputs.

Speeds: 20 to 160 bauds with coarse and fine adjustment on direct-reading dials; neon strobe lamp.

Relay Tests: Bias adjusted by making two dots on the circular trace coincide; transit time indicated by the trace arc-length.

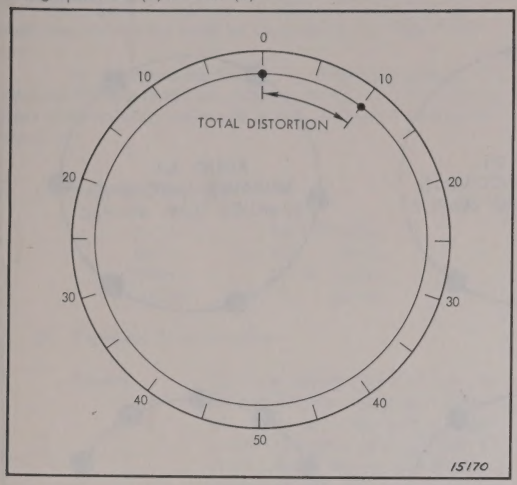


Figure 1-26. Ten Percent Distortion Displayed On Circular Sweep

(4) Equipment Required

Either Portable Power Supply, Model 14-104B or Rack-Mount Power Supply, Model 14-102/103D, furnishes all operating voltages to the Receiver.

(5) Fuses

All fuses for the Receiver are located in the associated power supply.

(6) Tube Complement

Qty	Type	Reference Number
9	12AU7	V4, V5, V8 through V14
3	12AX7	V3, V6, and V7
1	3RP1	V15
2	12AT7	V1 and V2

c. TDMS 14-200B Tel-A-Scan

(1) Functional Description

The Tel-A-Scan is a versatile oscilloscope specially designed for use with standard telegraph and low-speed data systems. It permits direct visual analysis of signal waveforms presented by a linear (A-Scan) cathode-ray tube (CRT) trace. The voltage of incoming signals is measured with 10 percent accuracy, without interfering with the waveform presentation. In addition to its TDMS applications, the Tel-A-Scan unit serves as an effective general purpose oscilloscope.

The vertical amplifier employed in this instrument is flat within three db from dc to 100 kc; this entails rise time displays of better than 4.0 microseconds. A modified phantastron circuit provides triggered linear sweeps in 10 continuously variable ranges from 30 microseconds to three seconds.

The INPUT SEL switch on the front panel selects any one of five pairs of input terminals (located on the rear of the unit) differentially connected to the vertical amplifiers. Three additional positions on the switch permit the vertical amplifiers to be connected to either or both of two front panel jacks.

A sweep magnifier provides a magnification of eight times and permits the time base to be positioned for enlarged viewing of any increment of the signal waveform displayed on the oscilloscope. A unique voltage calibration circuit permits the operator to position the retrace at any point on the face of the CRT tube by rotating the CALIB control. The amplitude of the signal can thus be measured directly without interrupting traffic. Signals can be further analyzed by interconnecting the unit with the TDMS 5EB-R.2 Transmitter and TDMS 6EB-R.2 Receiver. Terminals for such interconnection are conveniently located on the rear of the Tel-A-Scan.

(2) Physical Characteristics

Height	10-1/2 inches
Depth	15 inches
Width	5-1/2 inches
Weight	13 pounds

(3) Electrical Characteristics

(a) Deflection Amplifier

Amplifier (full gain):	0.25 VPP for one inch deflection
Undistorted Deflection:	2.5 inches maximum
Input:	Differential or single ended

(b) Sinusoidal Frequency Response (through amplifier)

Direct Coupling:	Within 3 db from dc to 100 kc
Rise Time (10-90%):	Better than 4.0 microseconds
Overshoot:	None
Decay:	None
Input Coupling (to vertical amplifiers):	DC or AC
Attenuation:	Direct or x 10, x 100, x 1000
Time Duration (driven sweep):	30 microseconds through 3 seconds
Magnification:	x 8
Synchronization:	Positive or negative internal, external, or 60 cps

(c) Intensity Modulation Circuit (Z Axis)

Input Impedance:	2 megohms
Sensitivity:	100 volts

Polarity: Positive

(d) Power Supply: Portable Power Supply Model 14-104B or Rack-Mount Power Supply Model 14-102/103D

(e) Calibration Voltage:

The calibration circuit permits the retrace to be positioned at any point on the face of the CRT tube with the CALIB control. The setting of the CALIB control, when multiplied by the factor indicated by the position of the attenuator switch (x 1, x 100, x 1000), will reveal actual voltage present at that point. When not required, the retrace is removed from the face of the tube by rotating the CALIB control to its extreme CCW position.

(4) Equipment Required

All operating voltages required by the Tel-A-Scan unit are supplied by either one of two available power supplies; the Portable Power Supply, Model 14-104B, or the Rack-Mount Power Supply, Model 14-102/103D. Functionally, these power supplies are identical.

(5) Fuses

All fuses for the Tel-A-Scan are located in the associated power supply.

(6) Tube Complement

Qty	Type	Reference Number
1	OB2	V17
1	6AL5	V14
1	6AU6	V13
1	6BC8	V1
1	6BH6	V10
2	6J6	V7, V11
4	12AU7	V8, V9, V15, V16
2	12AT7WA	V2, V3, V6, V12
1	3RP1	V20

d. TDMS 14-102/103D Rack-Mount Power Supply

(1) Functional Description

The Rack-Mount Power Supply furnishes all operating voltages for the three primary components of the TDMS system when they are used as rack-mounted units. Any unit can be inserted in any one of the three compartments.

Each TDMS unit is automatically mated to the power supply through a 24-pin Amphenol connector. A barrier strip on the rear of the Rack-Mount is arranged so that the identifying information on the rear of each TDMS unit clearly indicates the proper terminals for interconnection. Once the interconnections have been accomplished each unit must utilize the compartment originally wired for it.

Units are retained in the power supply by a fastening device located on the front of the Rack-Mount panel directly beneath the unit concerned. The force of an ejection spring located at the rear of each compartment must be overcome when the units are inserted in the compartments. The unit is locked into place by rotating the knurled knob below it one-quarter turn clockwise. To remove the units from the power supply, pressure must be applied on the front panel of the unit and the knurled knob rotated in a counterclockwise direction one-quarter turn. When pressure is released from the front panel, the unit will move toward the operator approximately two inches. Withdrawing the unit approximately one-half its length will give access to the recessed carrying handle.

Five fuses provide electrical overload protection, and two screwdriver-controlled potentiometers enable setting of the regulated voltages.

(2) Physical Characteristics

Height . . . . . 12-1/4 inches
Depth . . . . . 18-3/4 inches
Width . . . . . 18-7/8 inches
Weight . . . . . 29 pounds

(3) Electrical Characteristics

Input: 115 vac, 60 cps (105 to 125 vac; 48 to 62 cps)

Outputs: +450v, unregulated, 10%
+260v, regulated, 5%
-150v, regulated, 5%
-800v, regulated, 10%
6.3 vac, 60 cps

(4) Auxiliary Equipment

(a) The Test Cable, Model 14-107A, shown in Figure 1-27, permits testing, maintenance, or operation of the TDMS primary units outside of the Rack-Mount.

(b) To prepare a unit for checking or maintenance:

Step 1 Remove the power supply power cable from the outlet.

Step 2 Push the unit against the ejection spring and turn the knurled knob beneath it a quarter-turn counterclockwise.

Step 3 Release pressure and extract unit.

Step 4 Plug female end of test cable to Amphenol connector.

Step 5 Plug male end of test cable into Amphenol connector at rear of Rack-Mount compartment.

Step 6 Plug power cable into outlet.

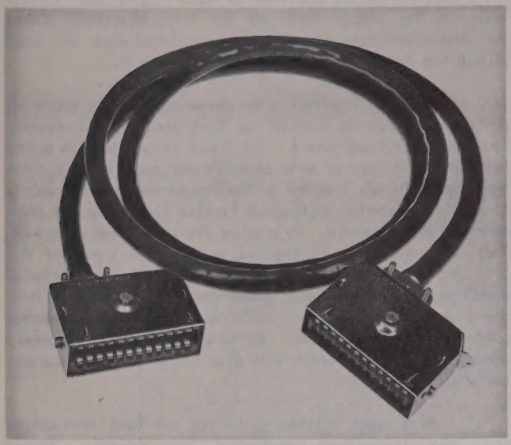


Figure 1-27. Test Cable

(c) High-Voltage Receptacle Protective Cover

Two rubber High-Voltage Receptacle Protective Covers, Model 9037-465, Figure 1-28, are supplied with each Rack-Mount Power Supply. These protective clips are inserted into the female portion of the Amphenol connector at the rear of the Rack-Mount accessory compartment immediately after a TDMS unit has been extracted. These are to protect the operator while working on the equipment.

WARNING

VOLTAGES DANGEROUS TO LIFE ARE PRESENT AT THE AMPHENOL CONNECTOR REMOVE POWER SUPPLY CABLE FROM OUTLET BEFORE INSERTING PROTECTIVE COVER.

(d) Power Plug Adapter

If the power outlet receptacle is not equipped with a ground connection, the Power Plug Adapter, Model 9037-470, Figure 1-29, should be used to receive the Rack-Mount Power Supply plug. Be sure the pigtail on the adapter is connected to ground.

(5) Fuses

Fuse	Type	Function
F4	3a, 125v	Primary power
F3	1/8a, 125v	DC output, +450v
F1	0.4a, 125v	DC output, +260v
F5	1/16a, 125v	DC output, -800v
F2	1/8a, 125v	DC output, -150v

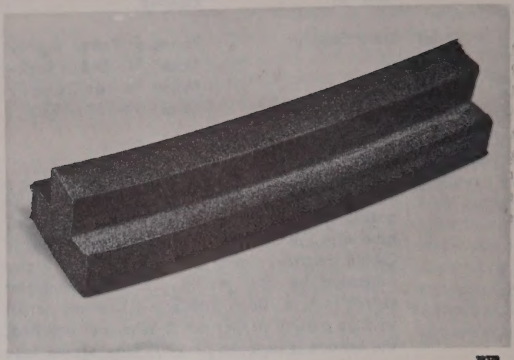


Figure 1-28. High Voltage Receptacle Protective Cover

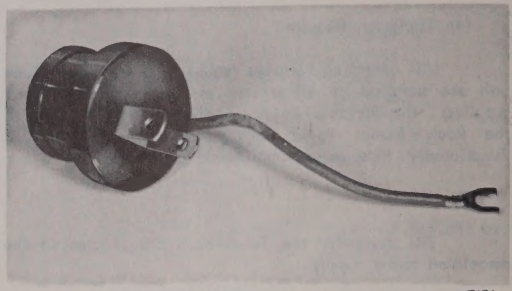


Figure 1-29. Power Plug Adapter

(6) Tube Complement

Qty	Type	Reference Number
1	6080	V1
1	6AU6	V2
1	5687	V3
1	OB2	V4

e. TDMS 14-104B Portable Power Supply

(1) Functional Description

The Portable Power Supply powers any one of the primary components of the TDMS system when it is used as a portable unit. The supply is mated to the unit through an Amphenol 24-pin connector and secured to the unit by four retaining screws. A barrier terminal strip is provided at the rear of the supply as a means for input/output connections to the associated TDMS unit. Three fuses provide electrical overload protection. A screwdriver controlled potentiometer enables setting of the regulated voltage for the plate supplies of the different TDMS units.

(2) Physical Characteristics

Height . . . . . 10-1/2 inches
Depth. . . . . 5 inches
Width. . . . . 5-1/2 inches
Weight . . . . . 14 pounds

(3) Electrical Characteristics

Input: 115 vac, 60 cps (105 to 125 vac, 48 to 62 cps)

Outputs: +450v, unregulated, 20%
+260v, regulated, 5%
-150v, regulated, 5%
-800v, regulated, 10%
6.3 vac, 60 cps

(4) Fuses

Fuse	Type	Function
F1	2 amp, 125v	Primary power
F2	0.25 amp, 125v	DC output, +260v, and -800v power supply
F3	1/16 amp, 125v	DC output, -150v power supply

(5) Tube Complement

Qty	Type	Reference Number
1	6080	V1
1	6CE5	V2
1	OA2	V3

f. TDMS 14-300A Utility Cart

(1) Functional Description

The TDMS 14-300A Utility Cart provides mobility for the TDMS system as shown in Figure 1-1. The three major units of the TDMS system, mounted in the Rack-Mount Power Supply, are secured in the enclosure at the top of the cart. The shelf below provides convenient storage space for the auxiliary equipment.

(2) Physical Characteristics

Height . . . . . 56 inches
Depth . . . . . 30 inches
Width . . . . . 22 inches
Weight . . . . . 40 pounds

3. PREPARATION FOR USE

a. Unpacking and Inspection

No special unpacking or handling techniques are required when removing the TDMS units from the shipping containers. Simply use the normal care and precautions as in handling electronic equipment of similar size and weight.

Check the packing list to assure that all units are accounted for, and immediately report any obvious shipping damage or shortages to the shipping agency.

b. Installation

(1) Transmitter, Receiver and Tel-A-Scan

Since the Transmitter, Receiver and Tel-A-Scan are portable test instruments, no special installation other than the attachment of portable power supplies or the insertion of the units in the Rack-Mount Power Supply is required. The Rack-Mount Power Supply is designed for mounting in standard 19-inch equipment racks or in the Model 14-300A Utility Cart.

CAUTION

Do not install this equipment in strong magnetic fields such as those sometimes found near transmitters, transformers, and power generating equipment, etc. as spurious CRT trace deflections may be introduced.

Do not install the equipment near radiators, steam pipes, or other heating devices.

(2) Rack-Mount Power Supply

Install the Rack-Mount Power Supply in any standard 19-inch rack and place any one of the TDMS units in any of the three compartments. (See interconnection diagram Figure 1-22.) Three TDMS Receivers or Transmitters may be operated simultaneously in one rack-mount power supply; however, only one Tel-A-Scan can be operated in one rack-mount power supply.

(3) Portable Power Supply

When major units of the TDMS system are to be used separately, or when use of the Rack-Mount Power Supply is not suitable, position a portable power supply at the rear of each TDMS unit and secure with the four screws provided (6/32 by 1/2).

c. Primary Power Required

The power requirement is 115 vac, 60 cps. However, the equipment will function with variations between 105 to 125 vac and 48 to 62 cps.

d. Power and Signal Connections

(1) Using the Rack-Mount Power Supply

This power supply is designed for mounting in a standard 19-inch rack. Any of the three compartments of the Rack-Mount Power Supply, Model 14-102/103D, will accommodate any one of the three primary inits, Transmitter, Receiver, or Tel-A-Scan. When properly connected the supply will power any one or all three of the units simultaneously. Simply insert the power supply power plug into a 110-volt ac outlet. If the outlet is not equipped with a ground pin, use Power Plug Adapter, Model 9037-470, Figure 1-29, and connect the adapter "pigtail" to ground. Power and signal connections are shown in Figures 1-21 and 1-22.

WARNING

VOLTAGE DANGEROUS TO LIFE IS PRESENT.

(2) Using the Portable Power Supply

The Portable Power Supply, Model 14-104B, supplies sufficient power to operate either the Receiver, Transmitter, or Tel-A-Scan, even though line voltages may fluctuate from 105 to 125 vac. The supply is positioned at the rear of the TDMS unit and secured with four mounting screws.

Input connections are then made on the 12-pin barrier strip on the back of the supply. Proper connection of each of the 12 pins is indicated on the rear and top of the particular TDMS being used. The Receiver permits a choice of connecting inputs to the Portable Power Supply or to the binding posts on either side of the Receiver unit, whichever is more convenient. Connections to the binding posts are as follows:

Binding Post	Accepts
INPUT 1 (Black)	One line of signal 1 (balanced or unbalanced)
INPUT 1 OR GRD (Black)	Other line (balanced), or ground side (unbalanced) of signal 1
INPUT 2 (Black)	One line of signal 2 (balanced or unbalanced)
INPUT 2 OR GRD (Black)	Other line (balanced), or ground side (unbalanced) or signal 2
GRD (Terminal)	Signal ground
MARK RELAY TEST (Red)	Connection to mark contact of relay under test
TONGUE RELAY TEST (Red)	Connection to armature of relay under test
SPACE RELAY TEST (Red)	Connection to space contact of relay under test
SCOPE SYNC (Red)	Connection to external oscilloscope for synchronization purposes.

Power is then applied to the supply by plugging the power plug into a 110 vac outlet. If the outlet is not equipped with a ground pin, use Power Plug Adapter, Model 9037-470, Figure 1-29, and connect the adapter "pigtail" to ground.

WARNING

VOLTAGE DANGEROUS TO LIFE IS PRESENT.

4. OPERATING INSTRUCTIONS

a. Preliminary Adjustments

(1) Transmitter

(a) Adjustments

To assure optimum equipment operation read Paragraphs 4b(1), (2), and (3) of this manual before performing the following instructions.

NOTE

The following adjustments should be performed by a maintenance technician.

Place the AMPLITUDE control in its furthest counterclockwise (CCW) position; place the FOCUS control in its mid-position. Slowly rotate the INTENSITY control CW until a spot appears in the center of the CRT. Rotate the AMPLITUDE control CW until the spot in the center of the CRT expands into a circle. This circle should be adjusted until it is two to two and one-half inches in diameter and just touches the inside of the scale markings. If these operations do not result in proper orientation of the circular trace; or if it is distorted in shape, cannot be properly focused, or is too small, the following preset operations should be performed.

NOTE

A 30-second thermal delay relay is incorporated to delay the application of B+ voltages to the tubes until after warm-up of the tube filaments.

CAUTION

The CRT in this instrument utilizes a total of 1025 volts, sufficient voltage to cause the bright spot to permanently damage the screen in a short time. Should it be necessary for the spot to remain in one place, adjust the INTENSITY control to dim the spot.

Step 1 Connect the associated power supply line cord to a source of 115-volt, 50 to 60 cycle ac power. Apply power to the Transmitter by turning the INTENSITY control CW until a slight click is heard. Allow a 10-minute warm-up for thermal delay relay operation and circuit stabilization.

Step 2 Remove the left panel by turning the four Air-Lock attachment devices one-fourth turn CCW.

Step 3 Turn the AMPLITUDE control on the front panel to its furthest CCW position; the internal control labeled COARSE AMP (top control on left rear of instrument) should be adjusted so that the circle appears and then turned CCW until the circle just collapses to a dot.

Step 4 Adjust front panel AMPLITUDE control for an approximately two and one-half inch

circle on the screen. When the circle appears, the SPEED indicator should light and remain lit while the circle is on the CRT screen.

Step 5 Adjust internal control VERT AMP (second control from the top, left rear of instrument) for proper circle shape.

Step 6 If required, adjust HORIZ POS and VERT POS internal controls for proper positioning.

Step 7 If required, adjust the ASTIG and FOCUS controls for a completely sharp trace. (These two controls complement each other.)

Step 8 Replace the side panel.

(b) Operation Checks

The following procedure is not intended to be a complete operational performance check.

Step 1 Connect a teletypewriter and line power supply to the appropriate MARK, TONGUE, or SPACE terminals on the right side of the Transmitter.

Step 2 Adjust FOCUS and INTENSITY controls until the trace is just visible.

Step 3 Set the following controls as indicated below:

RANGE:	Desired modulation range
VERNIER:	Exact modulation rate
DISPLAY:	OUTPUT NORMAL
SIGNAL SELECTOR:	CODER

Step 4 Connect terminal 9 on the power supply barrier strip to ground.

NOTE

The test message on the coder disc will be printed by the teletypewriter continuously. Break the ground connection to stop transmission at end of message.

Step 5 Place the SIGNAL SELECTOR switch in the KEYS position and then depress the proper keys for selection of the character desired. (Refer to Figure 1-24, Teletype Code Chart.) The teletypewriter will print the selected character continuously.

Step 6 Place the SIGNAL SELECTOR switch in the SPACE position. The teletypewriter will run "open".

Step 7 Place SIGNAL SELECTOR switch in the MARK position. The teletypewriter will run "closed".

(2) Receiver

Successful completion of the following procedure will assure that the equipment is operating properly. However, Paragraphs 4b(5) and (6) should be read before initiating the procedure.

Step 1 Set INTENSITY control, R546, to PWR OFF. Connect the power supply to a 115 vac, 60 cps power source.

Step 2 Set FOCUS control, R550, in its midposition.

Step 3 Set AMPLITUDE control, R465, in its CCW position.

Step 4 Set INPUT switch, S408, to LINE 1.

Step 5 Rotate INTENSITY control until a click is heard; the red POWER indicator should glow.

Step 6 Allow a warm-up interval of 10 minutes.

Step 7 Rotate INTENSITY control clockwise until a spot appears in the center of the CRT.

Step 8 Set TIME BASE switch, S404, to CIRCULAR.

Step 9 Rotate AMPLITUDE control clockwise until the spot blooms into a circular trace; the SPEED indicator, I2, should now glow.

Step 10 Adjust FOCUS control.

Step 11 Adjust AMPLITUDE control until the circular trace is just within, but not on, the graduated markings. If this cannot be achieved, perform the following steps.

a. Remove left side cover. If unit is installed in the rack-mount configuration, remove unit from rack and connect to Rack-Mount Power Supply with Test Cable 14-107A.

b. Rotate AMPLITUDE control fully CCW.

c. Adjust COARSE AMP (internal control, R467, located on left rear of unit) until circle appears; then back it off until the circle collapses into a dot.

d. Adjust AMPLITUDE control until the circular trace reappears and fills three-fourths of the CRT screen (about a two-inch diameter circle).

e. Adjust VERT AMP (internal control, R480, located on left rear) for circular trace.

f. Adjust VERT POS (internal control, R485) for vertical centering.

g. Adjust HORIZ POS (internal control, R473) for horizontal centering.

h. Adjust INTENSITY, FOCUS, and ASTIGMATISM (internal control, R574) for trace sharpness at all points.

i. Adjust AMPLITUDE control until the circular trace is just inside the graduated markings.

Step 12 Apply a 60 cps sine wave signal to the LINE 1 INPUT terminals (6.3v filament transformer or similar source).

Step 13 Set RANGE switch, S402, to 50 bauds; set VERNIER control, R453, to +10 bauds.

Step 14 Set SIGNAL switch, S403, to NEUTRAL +M.

Step 15 Set DISPLAY switch, S407, to BOTH; two dots 180 degrees apart should appear on the circular trace.

Step 16 Adjust VERNIER control, R453, until these dots are stationary.

Step 17 The reading on the MODULATION RATE controls should be 60 buads, plus or minus one half.

Step 18 Set RANGE switch to 70 bauds.

Step 19 Set VERNIER control to -10 bauds.

Step 20 Repeat Steps 16 and 17.

Step 21 Set RANGE switch to 30 bauds.

Step 22 Set VERNIER control to 0 bauds.

Step 23 Four dots 90 degrees apart should appear on the CRT trace. Adjust the VERNIER control until these dots are stationary. The MODULATION RATE controls should read 30 bauds, plus or minus one half.

Step 24 Set RANGE control to 90 bauds.

Step 25 Repeat Steps 22 and 23 except that the MODULATION RATE controls should read 90 bauds, plus or minus one half.

Step 26 Set RANGE control to 110 bauds.

Step 27 Set VERNIER control to +10 bauds.

Step 28 One bright dot should appear on the CRT trace. Adjust the VERNIER control until this dot remains stationary. The MODULATION RATE controls should now read 120 bauds, plus or minus one half.

Step 29 Set RANGE control to 130 bauds.

Step 30 Set VERNIER control to -10 bauds.

Step 31 Repeat Step 28.

Step 32 Apply a 150 cps sine wave to LINE 1 INPUT terminals from an accurate signal generator.

Step 33 Set RANGE switch to 150 bauds.

Step 34 Set VERNIER to 0. The two dots referred to in Step 16 above should be stationary; if not, adjust VERNIER.

Step 35 Set UNIT CODE switch, S406, to 4.

Step 36 Set TIME BASE switch to SPIRAL. Turn AMPLITUDE control CCW. A spiral trace should appear on the CRT screen, starting at the 0 mark and describing three and three - quarter turns. Turn AMPLITUDE control CCW slightly until the inside spiral is one inch in diameter.

Step 37 Set the UNIT CODE switch, sequentially, to each of its positions. The spiral should increase one turn for each progressive setting of the UNIT CODE switch. As each position is reached the AMPLITUDE control must be turned slightly clockwise to prevent spiral collapse. If spiral does collapse, place DISPLAY switch in the CIRCULAR position and adjust AMPLITUDE control per Step 11 i above.

(3) Tel-A-Scan

To assure optimum equipment operation read Paragraphs 4b(18), (19), and (20) of this manual before performing the following instructions.

CAUTION

The CRT in this instrument utilizes a total of 1025 volts, sufficient voltage to produce a spot bright enough to damage the screen permanently in a short time. Should it be necessary for the spot to remain in one place, dim its brightness with the INTENSITY control.

Step 1 Set INTENSITY control to PWR OFF; connect the male plug of the power cord to a 115 vac, 60 cps source.

Step 2 Set FOCUS in its mid-position.

Step 3 Set VERT POS control to the center of its range.

Step 4 Set HORIZ POS control to the center of its range.

Step 5 Turn MAG POS control off.

Step 6 Set INPUT SEL switch to LINE 1.

Step 7 Connect a 60 words per minute, polar, positive-mark telegraph signal to the line one terminals on the rear of the unit.

Step 8 Set the SYNC & HORIZ SEL switch to -INT.

Step 9 Turn the STABILITY control to the full CCW position.

Step 10 Turn the TRIGGER control to the full CCW position.

Step 11 Turn CALIB control to its full CCW position. In this position this control actuates a switch which disconnects the calibration circuit and actuates the blanking circuit.

Step 12 The AC-IN, DC-OUT pushbutton should be in the DC-OUT position.

Step 13 Since the total incoming signal will take 163 milliseconds for its presentation, set the RANGE switch to the .1-.3 SEC position.

Step 14 Set the VERNIER control to approximately 1.6 (from the settings of the RANGE and VERNIER controls an approximation of the time occupied by one character of the incoming signal is obvious).

Step 15 Turn on the Tel-A-Scan by turning the INTENSITY control clockwise (CW) one-half turn. The red POWER indicator should glow. Allow a warm-up interval of about 10 minutes.

Step 16 Turn the STABILITY control CW until a trace appears on the CRT screen.

Step 17 Position the input ATTENUATOR switch and adjust the VERT GAIN control until a pattern approximately one-inch high is obtained.

Step 18 Adjust the VERT POS and HORIZ POS controls to center the trace.

Step 19 Adjust the FOCUS control to obtain a sharp trace.

NOTE

If a sharp pattern cannot be obtained, remove the left dust cover and adjust the ASTIG control.

Step 20 Rotate the STABILITY control CCW until the trace just disappears.

Step 21 Turn the TRIGGER control CW until a stable trace appears on the CRT screen. It may be necessary to readjust the VERNIER control to obtain a stable pattern one character long. If the width of the pattern does not correspond to the engraving on the graticule, remove the left dust cover and adjust the SWEEP LG (length) control until the display matches the CRT scale.

Step 22 Turn the CALIB control CW until the pointer is at zero. The retrace should now show as a second trace on the CRT screen. This retrace should be a straight line centered on the pattern depicting the incoming signal. Turning the CALIB control CW should position the retrace line up and turning this control CCW should move this retrace line down.

Step 23 Turn the MAG POS control CW. The pattern should now be magnified approximately eight times. As this control is rotated the magnified portion of the display should move to the right. If the magnified trace does not start at the left side of the graticule, remove the left dust cover and adjust the MAG START POS control.

(4) Rack-Mount Power Supply

Remove the power supply cover by removing four retaining screws, Figure 1-30, and pulling straight back on the cover. Remove four retaining screws, Figure 1-31, and lower the power supply slowly downward on its hinges until it rests on its limiting brackets, Figure 1-32.

CAUTION

Do not touch tubes while they are hot.

To turn on the power supply and associated TDMS units turn the INTENSITY control (red knob on the attached TDMS units) clockwise and permit one minute for warm-up.

Check indicated voltages from the following points to chassis ground except where otherwise indicated.

WARNING

VOLTAGES DANGEROUS TO LIFE ARE PRESENT.

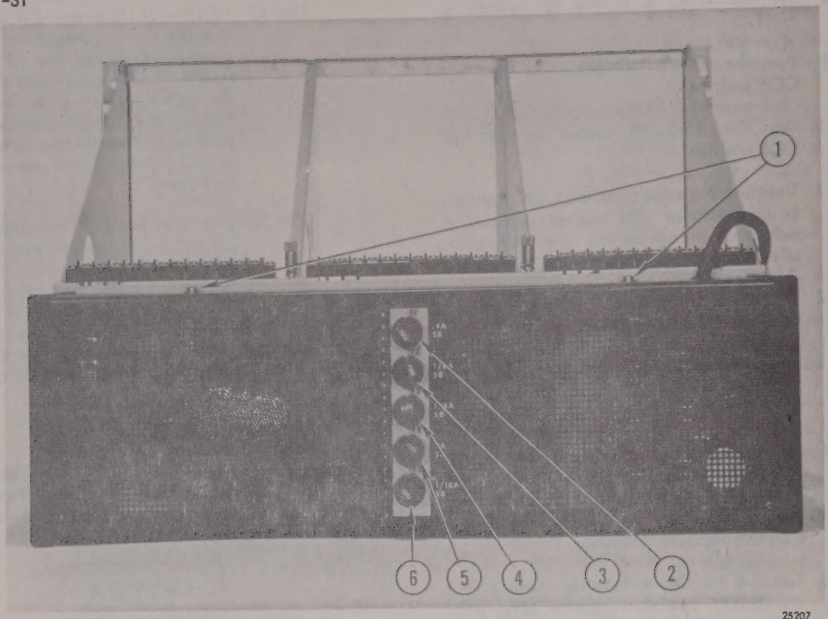
Voltage	Test Point
+450v, ±45v	Pin 6, J10
+260v, ±5v	Pin 19, J10 (if necessary adjust the 260 VOLT ADJ control, R14)
-150v, ±7v	Pin 7, J10 (if necessary adjust the -150 VOLT ADJ control, R38)
-800v, ±80v	Pin 4, J10
6.3v, ±0.3 vac	Pin 14, J10
*6.3v, ±0.3 vac	Pin 4, J10 to Pin 16, J10

*Note: This voltage is not referenced to ground; it is at a potential of -800 vdc. All other voltages are measured from pins on J10 to ground.

(5) Portable Power Supply

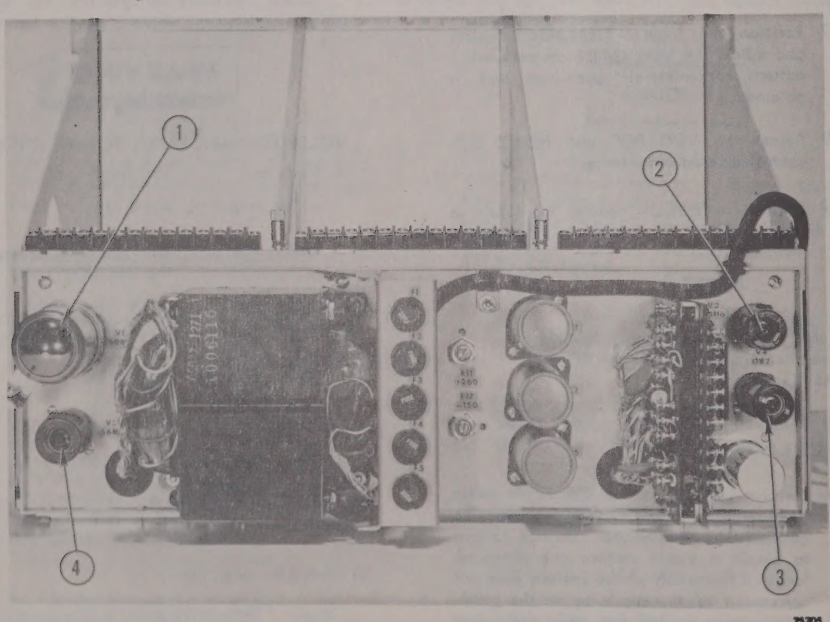
Step 1 Remove the power supply cover.

Step 2 To turn on the power supply and the attached TDMS unit, turn the INTENSITY control on



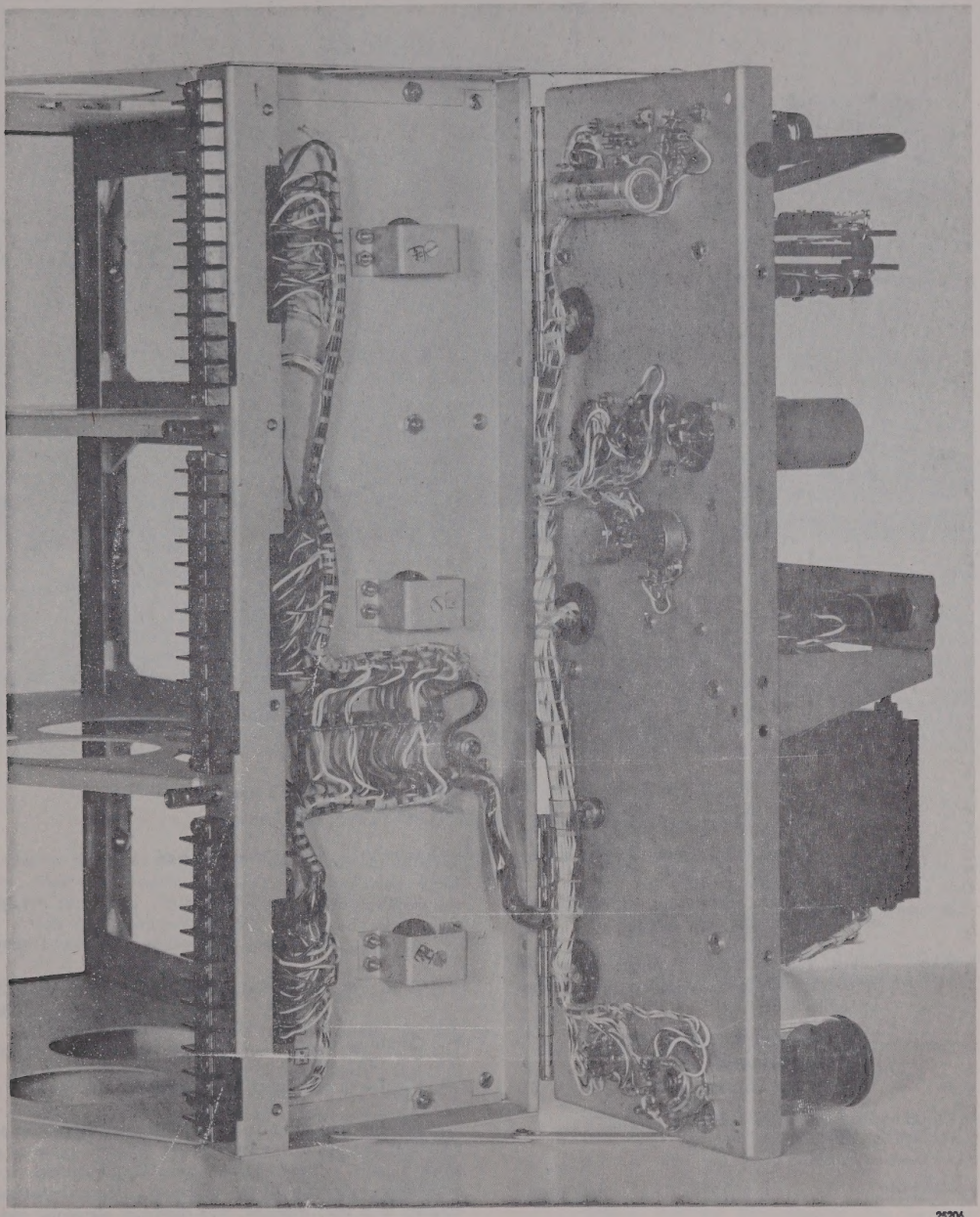
1. COVER RETAINING SCREWS (Additional two underneath)
2. F-1
3. F-2
4. F-3
5. F-4
6. F-5

Figure 1-30. Rack-Mount Power Supply Model 14-102/103D, Rear View



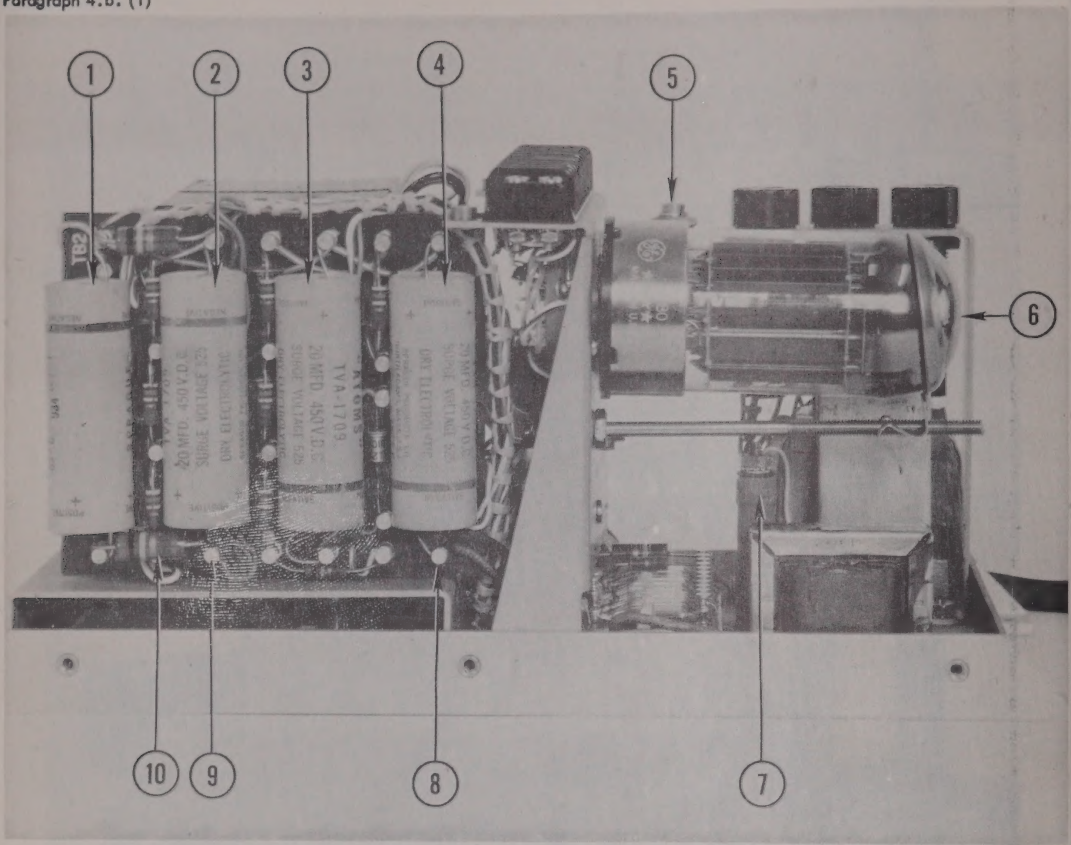
1. V1
2. V2
3. V4
4. V3

Figure 1-31. Rack-Mount Power Supply, Cover Removed



25206

Figure 1-32. Rack-Mount Power Supply, Chassis Lowered



25218

1. C10 3. C8 5. R8 7. R19 9. R2-C3 Junction
2. C3 4. C9 6. V1 8. -150V 10. R2

Figure 1-33. Portable Power Supply - Three-Quarter View Left - Cover Removed

the associated TDMS unit clockwise and permit ten minutes for warm-up.

Step 3 Check the following voltages from the junctions specified to chassis ground, unless otherwise indicated.

CAUTION

Do not test pins 8 and 9 of T1 to ground.

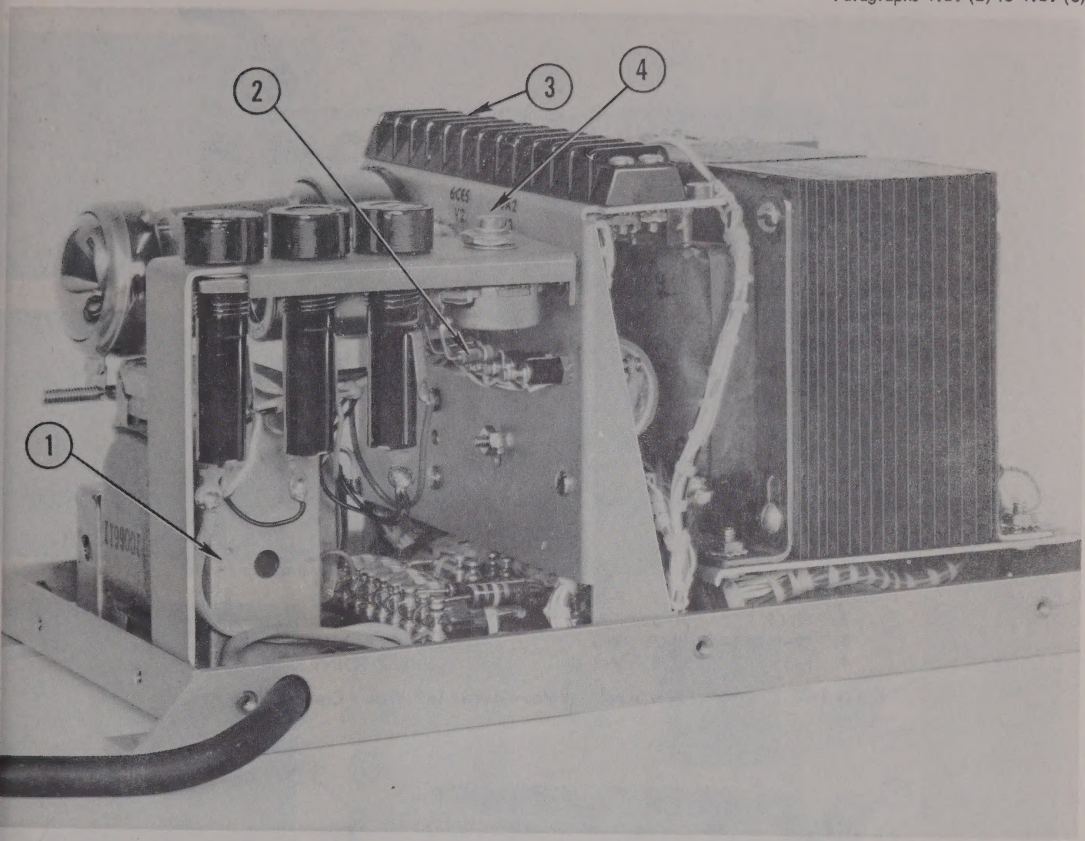
Voltage	Junction	Figure Reference
+450v, ±20%	R2, C3	1-33
+260v, ±5%	Pin 5, V1 (if necessary adjust VOLT ADJ, R8)	1-33
-800v, ±10%	I1, R13, R12	1-34
-150v, ±5%	Pin 2, V3	1-35
6.3v, ±0.3 vac	Pin 3, V2	1-35
6.3v, ±0.3 vac	Pins 8 and 9, T1	1-35 1-36

b. Operation

(1) Transmitter Functional Operation

The Transmitter is, primarily, a teletype test signal generator capable of transmitting six different types of telegraph signals. These signals can be transmitted at any modulation rate from 20 to 160 bauds. The code transmitted consists of a start element, five character elements, and one, one and one-half, or two stop-elements. Up to 50 percent short or long start-element distortion may be introduced into any test transmission composed of characters.

Facilities are provided for measuring the distortion of the test transmissions from the instrument itself, or for



1. L-1
2. R-4, 7 AND 9
3. R-8
4. TB-1

Figure 1-34. Portable Power Supply - Right Side - Cover Removed

measuring the speed and distortion of signals from an external source. Means for testing grounded or ungrounded input signals are provided. Polar telegraph relays can also be given a simulated operating test and can be adjusted under simulated operating conditions.

(2) Description of Transmitter Controls

Normal operating controls and indicators for the Transmitter are mounted on the front panel (Figure 1-37). Input and output terminals mounted on the sides of the unit are in parallel with a barrier strip located on the associated power supply. In order to gain access to the preset controls (Figure 1-38) the Transmitter's left side panel must be removed. The calibration controls are on the right side of the unit (Figure 1-39) and are to be adjusted only by a qualified maintenance technician. Table II lists all front panel controls and indicates their function; Tables III and IV list the binding post terminals on the left and right sides of the unit, respectively; Table V lists the barrier strip terminals.

(3) Transmitter Operating Procedures

(a) Transmitting

Step 1 After a 10-minute warm-up period, set the STOP PULSE switch for one, one and one-half or two stop-elements as required.

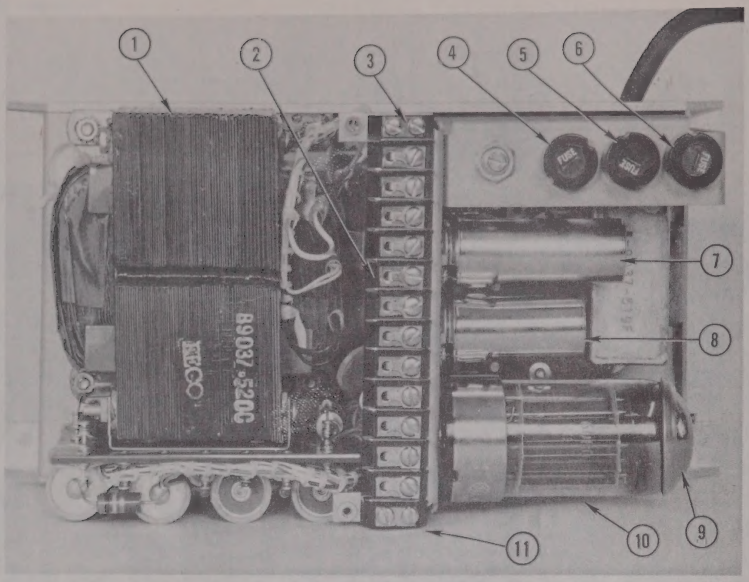
Step 2 Set the RANGE switch to the required speed range and make final speed adjustment with the VERNIER control.

Step 3 Set the SIGNAL SELECTOR switch to the type of signal that is required.

Step 4 Connect an external battery to the appropriate terminals (SPACE, or MARK or both) determined by the system in use.

Step 5 Connect the outgoing line between the TONGUE terminal and the appropriate battery connection.

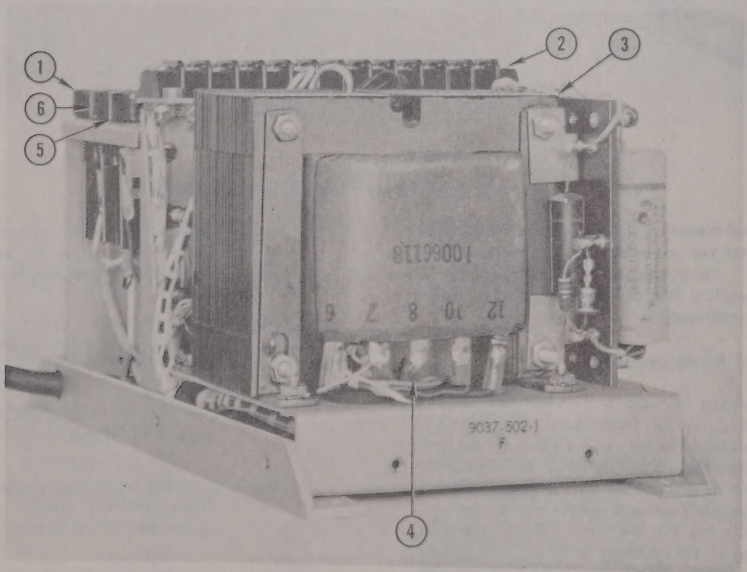
Step 6 To monitor the outgoing signal, set the DISPLAY switch to OUTPUT NORMAL. A bright spot should appear on the trace at "0".



25203

1. T-1
2. PIN 9
3. TB-1
4. F-3
5. F-2
6. F-1
7. V-3
8. V-2
9. V-1
10. L-2 (under)
11. PIN 3, 6.3 VAC CHECK POINT (under)

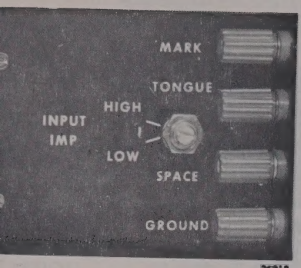
Figure 1-35. Portable Power Supply - Three-Quarter Left View - Cover Removed



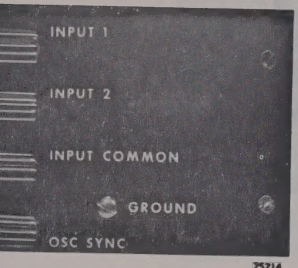
25213

1. F-1
2. TB-1
3. T-1
4. CRT FILAMENT CHECK POINT (-800 VDC PRESENT)
5. F-3
6. F-2

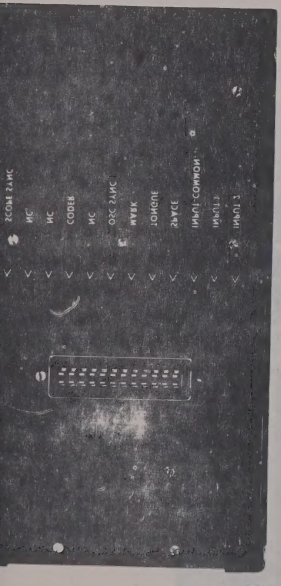
Figure 1-36. Portable Power Supply - Three-Quarter Bottom View - Cover Removed



25213



25214



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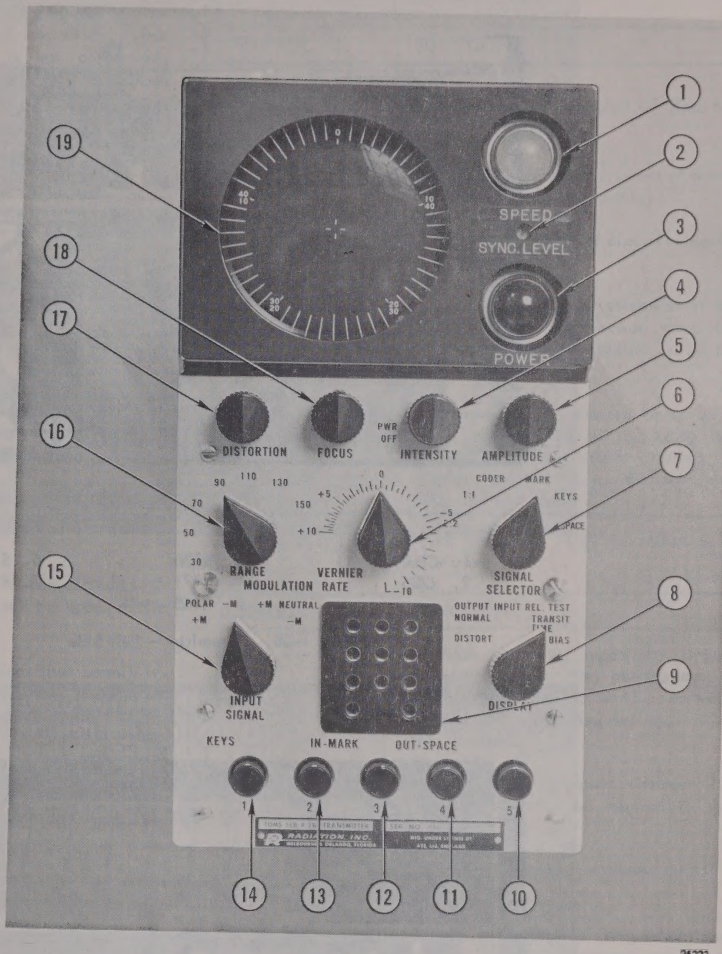
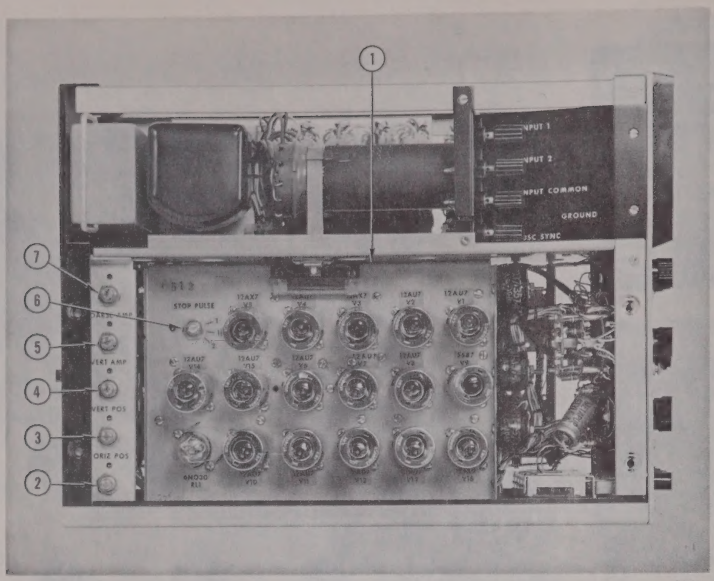


25223

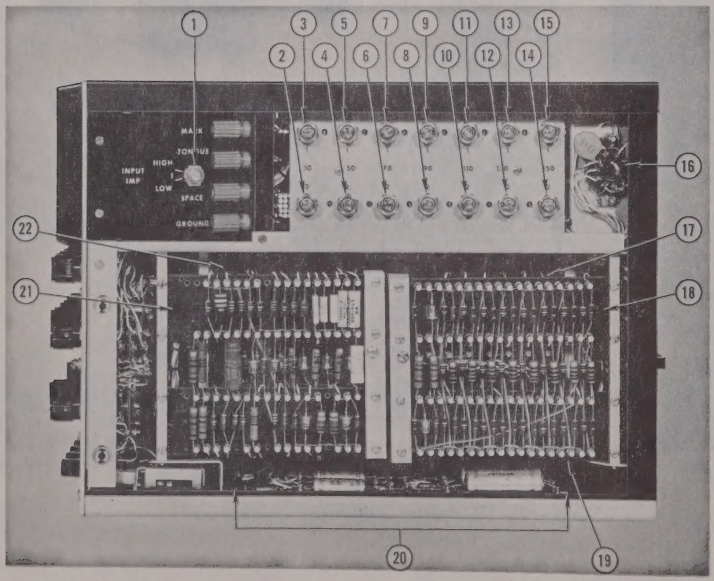
1. I-2
2. R163
3. I-1
4. R290 and S101
5. R129
6. R153
7. S104
8. S105
9. J102
10. S119
11. S118
12. S117
13. S116
14. S115
15. S103
16. S102
17. R213
18. R288
19. CRT GRATICULE

Figure 1-37. Transmitter Controls and Connections



1. CHASSIS
2. R285
3. R136
4. R171
5. R165
6. S112
7. R128

Figure 1-38. Transmitter - Left Side



1. S111
2. R322
3. R323
4. R324
5. R325
6. R326
7. R327
8. R328
9. R329
10. R330
11. R331
12. R332
13. R333
14. R334
15. R335
16. CODER SOCKET
17. TERMINAL BOARD "D" (under)
18. TERMINAL BOARD "C"
19. R301 (on "D" under)
20. LOWER TERMINAL BOARD
21. TERMINAL BOARD "A"
22. TERMINAL BOARD "B" (under)

Figure 1-39. Transmitter - Right Side

Step 7 To introduce distortion to a test transmission, set the DISPLAY switch to DISTORT and adjust the DISTORTION control to give the required degree of distortion. The DISTORTION control is not calibrated. Measurement of the degree of distortion is indicated on the CRT.

ABLE II. TRANSMITTER FRONT PANEL CONTROLS AND INDICATORS (Figure 1-37)

CONTROLS	FUNCTION
STORTION 13)	Permits distortion of the start element length by 50 percent with an accuracy of one percent.
CUS (R288)	Adjusts trace sharpness on the CRT.
TENSITY 90 and S101)	Combination potentiometer and on-off switch which controls both the main power and the brightness of the CRT sweep.
PLITUDE (R129)	The fine amplitude adjustment controlling the diameter of the circular trace.
EED (White icator Lamp, I2)	A neon lamp used in conjunction with a tuning fork to check the speed of the internal oscillator.
NC LEVEL (R163)	Screwdriver adjustment that permits an operator to control the amount or amplitude of the signals applied to the internal oscillator. This feature is used when it is desired to lock the transmitter to a standard frequency source.
WER (Red icator Lamp, I1)	This lamp indicates that power is applied to the equipment.
DULATION RATE: RANGE (S102)	This switch permits selection of seven ranges: 30, 50, 70, 90, 110, 130 and 150 bauds.
VERNIER (R153)	Permits 10 bauds to be added to, or subtracted from, the RANGE speed selector. It is calibrated from plus 10 through 0 to minus 10.
NAL SELECTOR 04)	A six-position switch which determines the type of signal to be transmitted.
UT SIGNAL 03)	Selects the proper line signal condition. The signal selected can be either negative (-M) or positive (+M) polar or neutral.
PLAY (S105)	Controls the signal trace display on the CRT by selection of:
NPUT:	For analysis of incoming signal.
OUTPUT:	DISTORT: Distorted transmission of test signal.

TABLE II. TRANSMITTER FRONT PANEL CONTROLS AND INDICATORS (Continued)

CONTROL	FUNCTION
OUTPUT:	NORMAL: Transmission of clear test signal.
REL TEST:	TRANSIT TIME: Measurement of transit time of relays by CRT display.
	BIAS: Measurement of bias of relays by CRT display.
KEYS 1-5 (S115 - S119)	These switches permit selection of any letter, figure or function when the SIGNAL SELECTOR switch is in the KEYS position.
Relay Test Socket J102	Accommodates a Western Union 202A relay or Model 14-101 ( ) Relay Test Adapter which permits testing of Western Electric 255A, Western Union 203, 204 and Sigma 72 relays.

TABLE III. TRANSMITTER BINDING POST TERMINALS - LEFT SIDE (Figure 1-38)

CONTROL	FUNCTION
INPUT 1	A high or low impedance input, depending upon the positioning of IMPEDANCE switch, S111. Between 25 and 250 volts may be applied to this terminal.
INPUT 2	A high impedance input. Between 2.5 and 25 volts may be applied to this terminal.
INPUT - COMMON GRD	Common terminal for both INPUT 1 and INPUT 2.
OSC SYNC	Permits connection of a synchronizing voltage from an external source to control the Transmitter's oscillator.

TABLE IV. TRANSMITTER CONTROLS AND BINDING POST TERMINALS - RIGHT SIDE (Figure 1-39)

CONTROL	FUNCTION
INPUT IMP (S111)	Permits selection of either HIGH or LOW impedance for INPUT 1.
TONGUE (terminal)	Armature contact of the output relay (RL3) located on the left side, top-rear of the Transmitter.
MARK (terminal)	Mark contact of the output relay.
SPACE (terminal)	Space contact of the output relay.
GRD (terminal)	Ground for the Transmitter case and circuitry.

TABLE V. POWER SUPPLY BARRIER STRIP TERMINALS
(Figure 1-37)

CONTROL	FUNCTION
INPUT 2 (terminal 1)	A high impedance signal between 2.5 and 25 volts may be applied to this terminal.
INPUT 1 (terminal 2)	Input for a high or low impedance signal having an amplitude between 25 and 250 volts, depending upon the positioning of the input IMPEDANCE switch S111.
INPUT-COMMON	Common terminal for both INPUT 1 and INPUT 2.
SPACE (terminal 4)	This terminal is connected directly to the space contact of the output relay, RL3.
TONGUE (terminal 5)	This terminal is connected directly to the armature of the output relay, RL3.
MARK (terminal 6)	This terminal is connected directly to the mark contact of output relay, RL3.
OSC SYNC (terminal 7)	Used to sync the oscillator of the instrument with an external source.
NC (terminal 8)	No connection is made to this terminal.
CODER (terminal 9)	When shorted to ground, permits the coder and scale-of-two (V14) circuitry to operate continuously. When disconnected from ground, coder transmits one test message and stops, scale-of-two becomes inoperative.
NC (terminal 10)	No connection is made to this terminal.
NC (terminal 11)	No connection is made to this terminal.
SCOPE SYNC (terminal 12)	Used for synchronizing an auxiliary oscilloscope.

(b) Distortion Measurement Function - Outgoing Signals

With the instrument set up and operating, as detailed in the preceding paragraph, two dots may be seen on the display. One of these dots will be at "0" on the CRT, the other may be displaced to right or left, depending on the positioning of the DISTORTION control (if this control is set to "0" distortion only one spot will be visible). When the DISTORTION control is rotated, a second dot will move around the trace, indicating the degree of distortion. A full 360 degrees is equivalent to 50 percent distortion. An engraved graticule is fitted over the face of the CRT, giving direct readings of distortion percentage. Displacement in a CCW direction denotes short - start distortion. Similarly, displacement in a CW direction denotes long-start distortion.

(c) Displacement and Speed Measurement - Incoming Signals

In the absence of distortion all the dots will be superimposed. Distortion will be indicated by displacement of the dots over an arc. The total distortion is indicated by the distance between the most widely separated dots, and the distortion percentage is read directly from the calibrated graticule. When used for checking incoming signals of multiples of one-half unit, the Transmitter can be used for other speed checks by the ratio method (Figure 1-25). In this mode of operation the oscillator of the Transmitter can be slaved to an outside source, provided that the RANGE and VERNIER controls are set to correspond to the approximate frequency. Distortion can be measured when the circular trace is being utilized by reading the distance between any two or more dots relative to the percentage printed on the CRT scale. If the double-dot method is being used (1:2 ratio) the percentage must be multiplied by two, etc.

Step 1 After preliminary adjustment and warm-up, set the SIGNAL INPUT switch to correspond to the mark polarity of the incoming signal.

Step 2 Set the DISPLAY switch to INPUT.

Step 3 Set the RANGE switch to the appropriate speed range.

Step 4 Connect the line carrying the signal to be monitored between INPUT 1 or INPUT 2 and INPUT - COMMON GRD terminals, depending on its amplitude and matching impedance required. If INPUT 1 is used set INPUT IMP switch to the appropriate position.

Step 5 A group of bright dots should appear on the CRT display. Adjust the VERNIER control until the dots become stationary. The speed of the incoming signal is now read from the setting of the RANGE switch and VERNIER controls.

NOTE

In the receiving mode any of the transmitting functions can be operated simultaneously. However, the transmitted signals cannot be displayed on the CRT as this is used for display of the incoming signals. By employing both the transmitting and receiving functions simultaneously, a signal can be transmitted to the input of a unit to be tested and the output of that unit may be monitored on the Transmitter CRT.

(d) Relay Test - Bias

The front panel connector will accommodate a Western Union 202A Relay. The standard Relay Adapter Model 14-101 (Figure 1-40) will accept the Sigma 72, Western Electric 255A, or Western Union 203 and 204 relays. Adapters for other standard relays are available on special order.

Step 1 After making general adjustments and allowing for 10 minutes warm-up, set the RANGE and VERNIER controls to the desired speed.

Step 2 Set the DISPLAY switch to BIAS.

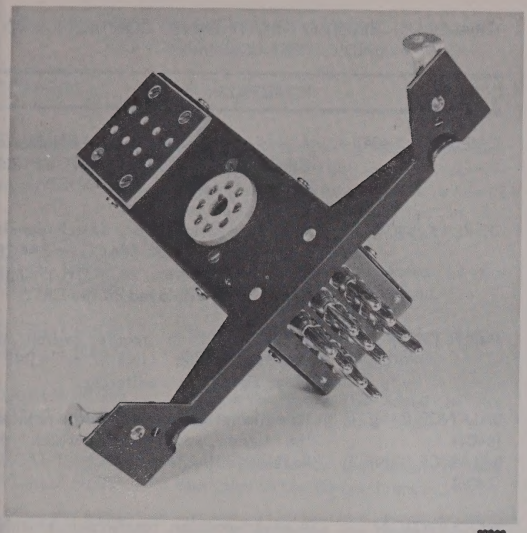


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Figure 1-40. Relay Test Adapter, Model 14-101

Step 3 Set SIGNAL SELECTOR to 1:1 or 2:2 reversals.

Step 4 Plug the telegraph relay to be tested into the relay test socket or adapter on the front panel of the instrument and adjust the relay as necessary until the tongue vibrates. One or more dots should appear on the circular trace. The relay is correctly adjusted for neutrality when the dots coincide.

(e) Relay Test - Transit Time

Step 1 After making general adjustments and allowing 10 minutes warm-up, set the RANGE and VERNIER controls to desired speed.

Step 2 Set the DISPLAY switch to TRANSIT TIME.

Step 3 Set the SIGNAL SELECTOR switch to 1:1 or 2:2 reversals.

Step 4 Plug the relay to be tested into the relay test connector or adapter on the front of the instrument. A stationary display should now be seen on the CRT. Since the time-base of the instrument completes two revolutions for each cycle of relay operation, the length of the bright trace represents the transit time as a percentage of total operating time (assuming the relay is bias-face).

(f) Transit Time Calculation

Actual transit time of the relay under test may be calculated from the length of the arc on the CRT. Since the time base of the instrument is working at a frequency (in cycles per second) twice that of the baud rate, the number of 360-degree scans per second may be arrived at by division. Once the time per scan is known, the actual transit time may be arrived at by multiplying the time per scan by the percentage reading of the arc length on the CRT.

For example, if the modulation rate is 50 bauds, the CRT time base is working at 100 cps (twice the baud rate). Dividing one second by the number of scans per second (100) yields an answer of 0.010 second (10 milliseconds) per scan. Assuming that the transit time arc on the CRT extends from zero to 20, a 20 percent reading is obtained. Multiplying the time for one scan (0.010 second) by the transit time percentage (0.20) the actual relay transit time is found to be 0.002 second, or two milliseconds.

(g) Relay Test - Contact Bounce

Set up and test the relay as for transit time. Contact bounce may be observed as bright spots, near the ends of the transit-time trace.

(4) Receiver Functional Operation

Degrading distortion may be present even though a teleprinter or other data recording device is apparently operating correctly. With the TDMS Receiver the operator can detect distortion, measure it, and determine its nature and probable cause even when cryptograms or code groups are being transmitted making message errors impossible to detect. Once the nature of the distortion is known, it is often possible to correct the fault before a link becomes unserviceable. Distortion caused by a badly tuned receiver in a radio link, for example, can be corrected without interrupting the flow of traffic. Even in those instances where distortion is induced by a cause beyond the control or diagnostic ability of an operator, with a little preliminary briefing he can tell when a circuit is deteriorating and to what degree.

The TDMS Receiver accepts start-stop and synchronous teletypewriter signals of either polarity and provides a cathode-ray tube display from which distortion may be read directly. Synchronous signals are displayed on a circular trace, while start-stop signals are displayed on a spiral trace. Each character element transition appears as a dot on a different spiral loop, allowing direct measurement of individual element distortion.

Undistorted signals cause the dots to form a vertical radial line. Distorted signals displace the dots to the right or left, except for the start-signal dot. The percentage of distortion is indicated on the circular scale, calibrated in two-percent increments, on the face of the cathode-ray tube. Bias, characteristic, and fortuitous types of distortion are determined by the relative displacement of individual dots. Any number of code elements from 4 to 14 are displayed at speeds from 20 to 160 bauds. Speed can be read directly from the calibrated MODULATION RATE dials and monitored by means of the SPEED indicator lamp, I2, and a tuning fork.

A Z-axis terminal permits the Tel-A-Scan to be used to show the Receiver sampling level. The Z-axis output causes a dot to appear on the oscilloscope trace at the point on the waveform where the Receiver is triggered. By using the Receiver BALANCE controls, R405 and R406, the waveform can be sampled at any desired point. At the same time observation of distortion can be made on the Receiver CRT.

Polar relays can be checked for bias, transit time, and contact bounce by connecting the relay armature and contacts to the terminals on the upper right side. The relay is then pulsed by an external source. Bias is measured and the adjustment monitored by two bright dots on the circular trace. Bias is zero when the dots coincide.

Transit time and contact bounce are indicated by the arc-length of a bright trace. (When a TDMS Transmitter is available, it is preferable to use it for relay checking instead of the Receiver since a connector mating with the relay is provided and internal pulsing circuits operate the relay directly.)

(5) Description of Receiver Controls

Front panel controls, right side connections and controls, and left side connections and controls, are listed and described in Tables VI, VII, and VIII, and are illustrated in Figures 1-41, 1-42, and 1-43, respectively.

TABLE VI. RECEIVER FRONT PANEL CONTROLS AND INDICATORS (Figure 1-41)

CONTROL	FUNCTION
PWR OFF (S401)	A two-position rotary switch actuated by the clockwise rotation of the INTENSITY control. In the "on" position, it applies ac power to the power supply; in the PWR OFF position, it disconnects ac power from the Receiver.
POWER (I-1)	A red lamp which lights when ac power is applied by the PWR OFF-ON switch; it is extinguished when ac power is disconnected from the Receiver.
INTENSITY (R546)	A potentiometer controlling the brightness of the CRT trace.
SPEED (I-2)	A neon lamp used in conjunction with a tuning fork to check the speed of the oscillator. A 50-cycle tuning fork should show the neon extinguished when the Receiver is running continuously and adjusted to 50 bauds.
SYNC LEVEL (R570)	A screwdriver-controlled potentiometer which controls the amplitude of an external sync signal used to synchronize the oscillator.
CRT Graticule	A circular scale graduated in 50 equal divisions; each division represents two-percent distortion.
FOCUS (R550)	A potentiometer controlling the sharpness of the CRT trace.
AMPLITUDE (R465)	A potentiometer controlling the size of the circular or spiral trace. (Normally, the largest possible diameter circle or spiral results in the most accurate readings.)

TABLE VI. RECEIVER FRONT PANEL CONTROLS AND INDICATORS (Continued)

CONTROL	FUNCTION
TIME BASE (S404)	A two-position toggle switch selecting CIRCULAR or SPIRAL trace for CRT display.
DISPLAY (S407)	A three-position rotary switch permitting either a MARK-SPACE or SPACE-MARK changeover, or BOTH changeovers, to be displayed on the CRT.
INPUT (S408)	A two-position toggle switch for selecting either LINE 1 or LINE 2 input signal for monitoring.
BALANCE (LINE 1) (R405) BALANCE (LINE 2) (R406)	Potentiometers determining the point on the signal waveform at which the Receiver will operate.
MODULATION RATE RANGE (S402)	A seven-position rotary switch which selects baud settings (30, 50, 70, 90, 110, 130 or 150). The selected setting is used to determine the range over which the VERNIER control will be effective. Adding (or subtracting) the setting on the VERNIER control to (or from) the setting on the RANGE switch gives the speed of the signal.
VERNIER (R453)	A potentiometer which adjusts the Receiver speed within the selected range plus or minus 10 bauds.
UNIT CODE (S406)	An eleven-position rotary switch used to set the Receiver to the number of character elements, including the start and stop elements, of the received signal. The number of turns in the spiral sweep corresponds to this switch setting.
SIGNAL (S403)	A six-position rotary switch used to match Receiver operation to the type (polar or neutral) and mark polarity of the incoming signal. It also sets up the proper circuits for testing the transit time and the bias of relays.

TABLE VII. RECEIVER RIGHT SIDE CONNECTIONS AND CONTROLS (Figure 1-42)

CONTROL	FUNCTION
IMPEDANCE (S409)	Controls the input impedance to the incoming signals; a HIGH setting presents 220K ohms, a LOW setting presents 270 ohms impedance.
SCOPE SYNC (red)	A binding post from which a signal is taken to synchronize an external oscilloscope. This terminal is also connected in parallel to the barrier strip on the power supply.

TABLE VII. RECEIVER RIGHT SIDE CONNECTIONS AND CONTROLS (Continued) (Figure 1-42)

CONTROL	FUNCTION
ELAY TEST MARK, TONGUE, nd SPACE) (red)	A set of three binding posts which connect to the external relay or contacts which are to be tested. (These terminals are also parallel-connected to the barrier strip on the power supply.)
0/CAL 1 (R601) 0/CAL 2 (R608)	Used to calibrate the speed of the oscillator in the 30-baud range.
0/CAL 1 (R600) 0/CAL 2 (R607)	Used to calibrate the speed of the oscillator in the 50-baud range.
0/CAL 1 (R599) 0/CAL 2 (R606)	Used to calibrate the speed of the oscillator in the 70-baud range.
0/CAL 1 (R598) 0/CAL 2 (R605)	Used to calibrate the speed of the oscillator in the 90-baud range.
10/CAL 1 (R597) 10/CAL 2 (R604)	Used to calibrate the speed of the oscillator in the 110-baud range.
30/CAL 1 (R596) 30/CAL 2 (R603)	Used to calibrate the speed of the oscillator in the 130-baud range.
50/CAL 1 (R595) 50/CAL 2 (R602)	Used to calibrate the speed of the oscillator in the 150-baud range.

TABLE VIII. RECEIVER LEFT SIDE CONNECTIONS AND CONTROLS (Figure 1-43)

ONTROL	FUNCTION
OARSE AMP 467)	Controls the primary size of the circular trace.
RT AMP (R480)	Controls the shape of the circular trace.
RT POS (R485)	Controls the vertical position of the image on the CRT screen.
ORIZ POS (R473)	Controls the horizontal position of the image on the CRT screen.
TIGMATISM 74)	Controls the uniformity of sharpness of the image on the CRT screen.
YING (S410)	Used on neutral current telegraph keying; set in the REVERSE position when there is no voltage in the marking condition.
C START (R434)	Controls the amplitude of the oscillator start pulse. (Interactive with OSC HOLD control.)
C HOLD (R436)	Determines oscillator clamping point. (Interactive with OSC START control.)
PUT 1, INPUT 2 ack) GRD	Two sets of binding posts and a ground terminal which can accept the two incoming signals. (These terminals are connected in parallel to the barrier strip on the power supply.)

(6) Preliminary Receiver Starting Procedure

Follow the procedures outlined below before placing the Receiver in operation.

Step 1 Attach the Receiver to the associated power supply (Refer to Figure 1-21).

Step 2 Check accuracy of all input connections (Paragraph 3d).

Step 3 Set FOCUS control in its midposition.

Step 4 Set AMPLITUDE control in its CCW position.

Step 5 Set INPUT switch at appropriate position.

(7) Receiver Starting Procedure

Follow the procedures below to place the Receiver in operation. If abnormal indications are obtained, place the INTENSITY control at PWR OFF and refer to Paragraph 5b (g).

Step 1 Rotate INTENSITY control until a click is heard. The red POWER indicator should glow.

Step 2 Allow a warm-up of 10 minutes.

Step 3 Set TIME BASE switch to CIRCULAR.

Step 4 Rotate INTENSITY control until a spot in the center of the CRT is visible.

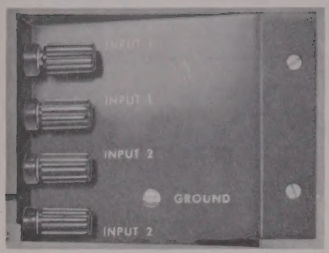
Step 5 Rotate AMPLITUDE control clockwise until the circular trace is just inside, but not on, the graduated markings (until all points along the periphery of the circle touch the inside edge of the graduated markings). The SPEED indicator should now glow.

(8) Receiver Stopping Procedure

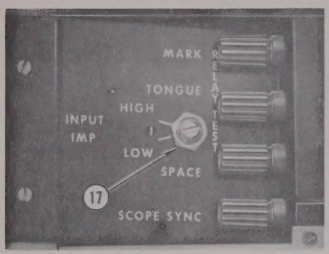
To turn the Receiver off, rotate the INTENSITY control to the PWR OFF position.

(9) Distortion Analysis

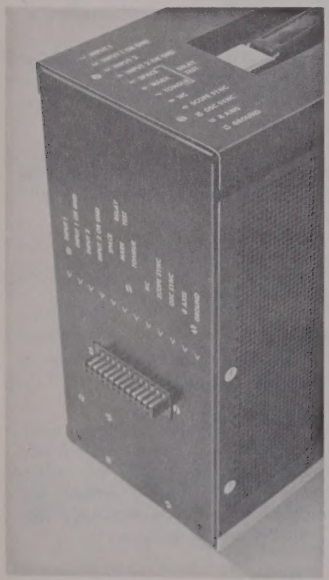
It is imperative that undue distortion discovered in one link of a telegraph or data system complex be minimized or removed as soon as possible. Ignoring a distortion condition in one link can only result in distortion in succeeding links, and the distortion in the several links may be cumulative.



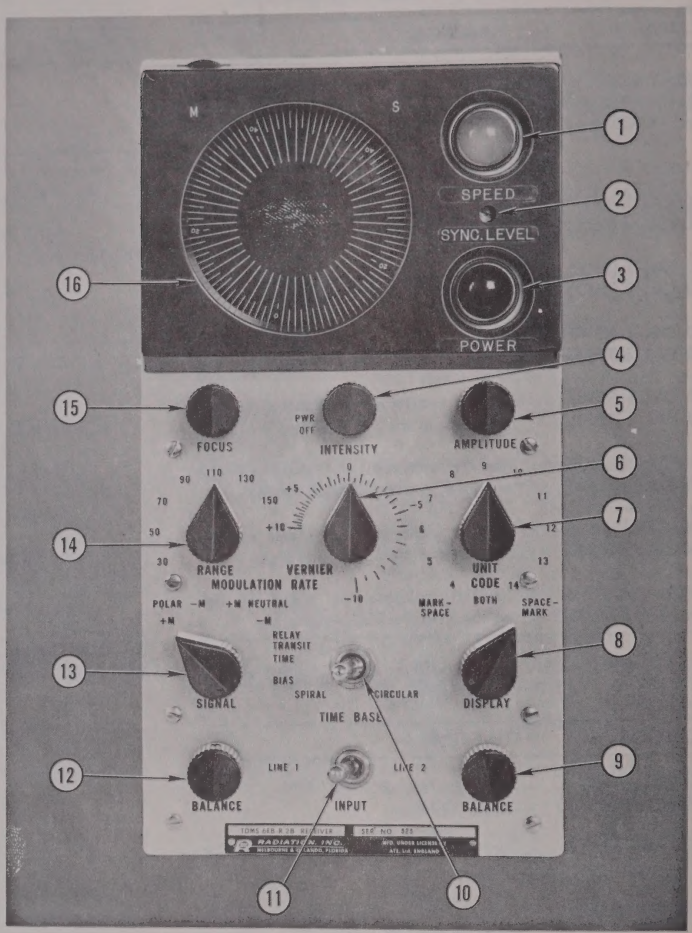
25212



25222



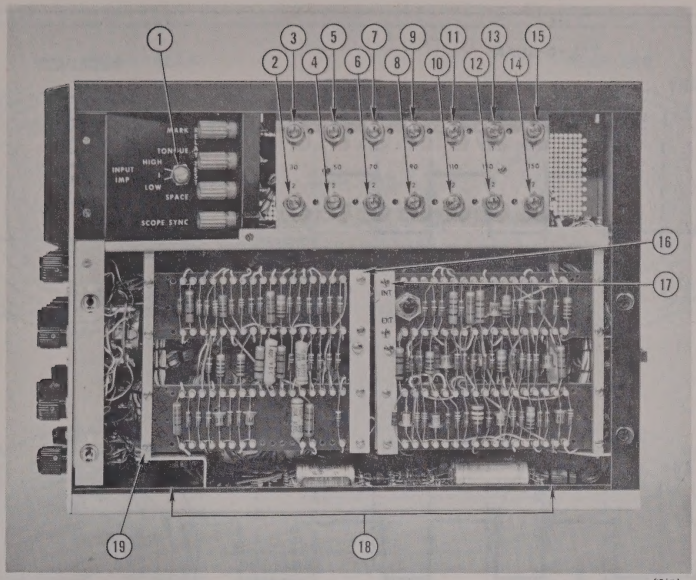
20992



25211

1. I-2
2. R570
3. I-1
4. R546 and S401
5. R465
6. R550
7. S406
8. S407
9. R406
10. S404
11. S408
12. R405
13. S403
14. S402
15. R550
16. CRT GRATICULE
17. S409

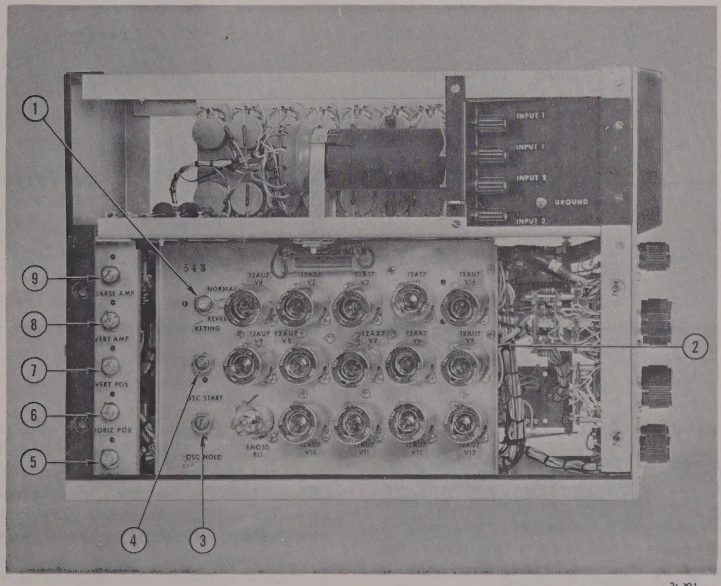
Figure 1-41. Receiver Controls and Connections



25201

1. S409
2. R608
3. R601
4. R607
5. R600
6. R606
7. R599
8. R605
9. R598
10. R604
11. R597
12. R603
13. R596
14. R602
15. R595
16. TERMINAL BOARD D
17. TERMINAL BOARD C
18. LOWER TERMINAL BOARD
19. TERMINAL BOARD A (there is no Terminal Board B in this unit)

Figure 1-42. Receiver - Right Side - Cover Removed



25204

1. S410
2. CHASSIS
3. R436
4. R434
5. R574
6. R473
7. R485
8. R480
9. R467

Figure 1-43. Receiver - Left Side - Cover Removed

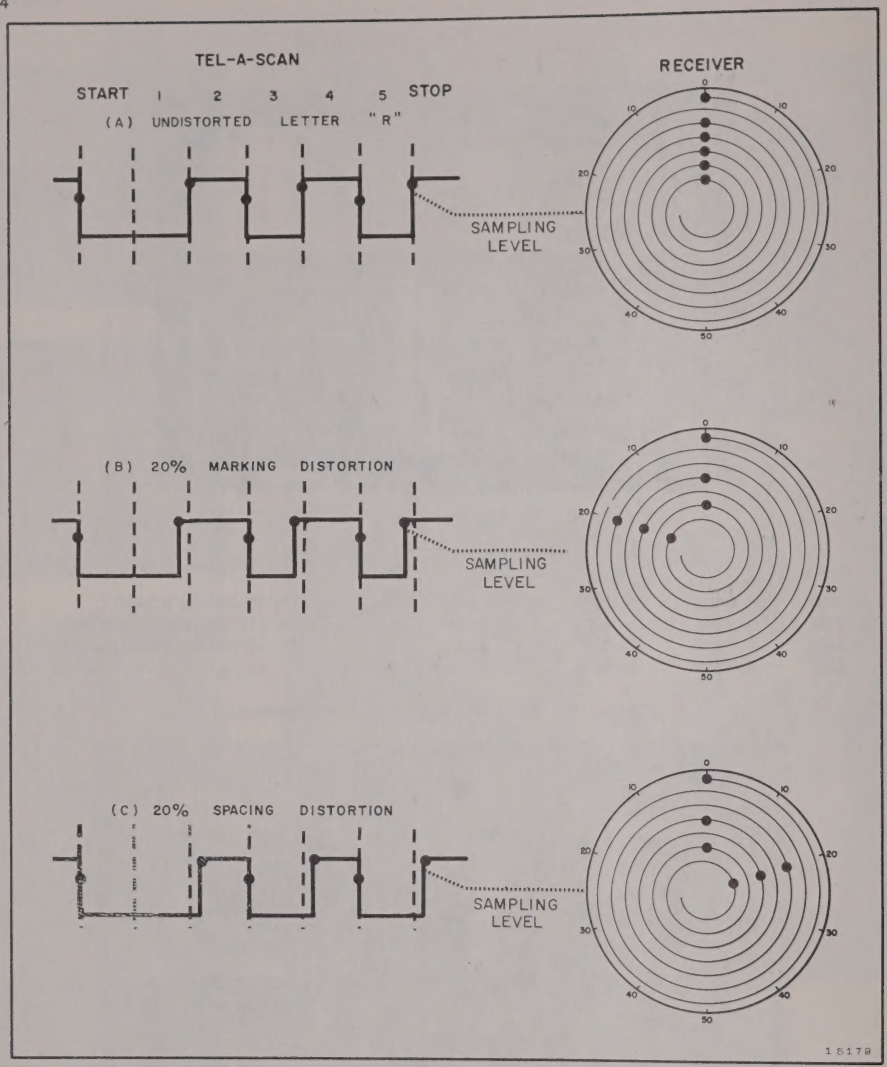


Figure 1-44. Bias Distortion

(a) Bias Distortion

Bias distortion is the uniform lengthening or shortening of the marking or spacing elements, one at the expense of the other. The total time allocated to one mark and one space never changes; only the length of the marking or spacing element changes. If the mark is lengthened, the space will be shortened by the amount that the mark is lengthened. If the distortion of the marking or spacing elements is not uniform and repetitive some other form of distortion is taking place. Bias distortion can change from one hour to the next, or with one adjustment of the equipment to another; however, only a few points in a telegraph transmission system are capable of producing bias distortion.

Figure 1-44 (A) illustrates the simultaneous display on the TDMS Receiver and Tel-A-Scan units of a normal bias-free telegraph signal for the letter "R". In Figure 1-44 (B) the same character is displayed on both units but with a 20 percent marking bias. In Figure 1-44(C) the displays of both units are depicted with a 20 percent spacing bias.

A maladjusted relay causing the armature to hold longer on the space contact can cause spacing bias; if the relay is adjusted to hold longer on the mark contact, marking bias results.

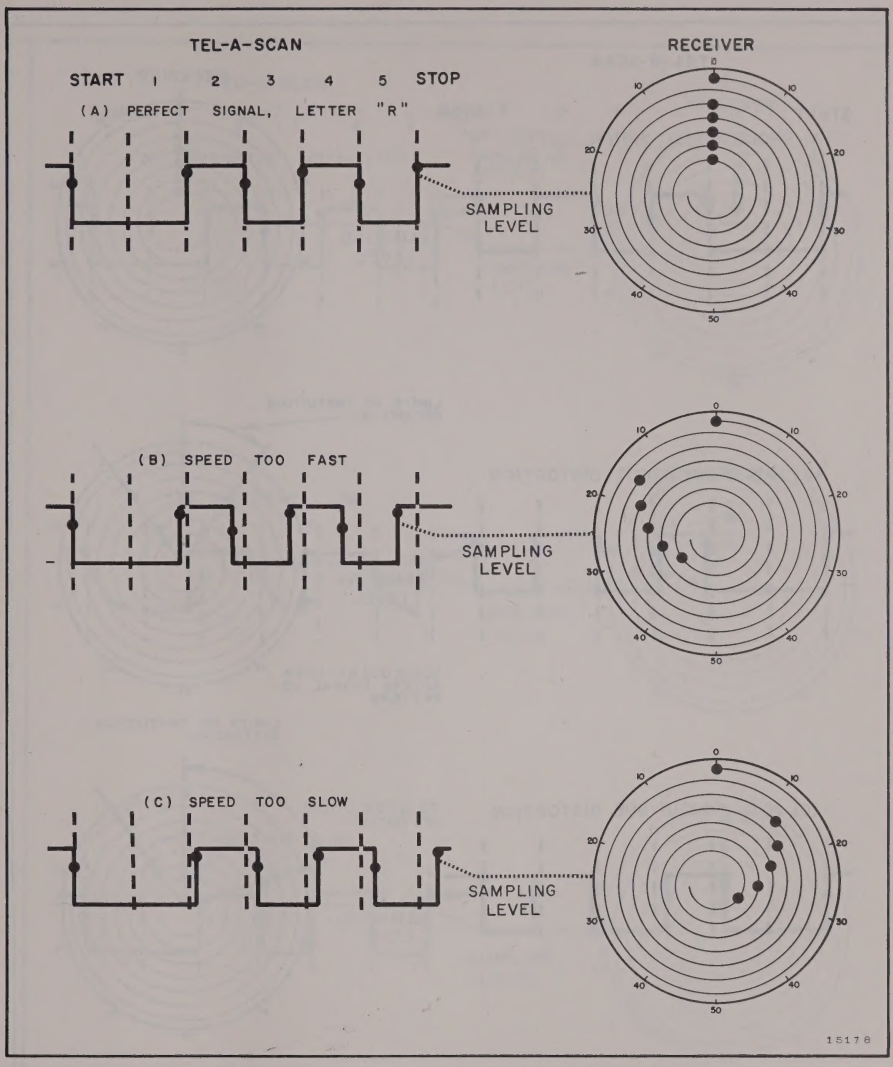


Figure 1-45. Speed Distortion

(b) Speed Distortion

Speed distortion, in that it involves distortion of the space and mark element lengths, is similar to bias distortion. However, in speed distortion the total time of one mark and one space element changes, the lengths of the mark and space elements each remaining 50 percent of the total time. On the other hand, in bias distortion either the space or mark element is longer while the other is shorter; the total time for one space and one mark element remains constant. Speed distortion can not produce bias distortion.

Figure 1-45 (A) shows the TDMS Receiver and Tel-A-Scan displays when the speed of the equipment is normal. Figure 1-45 (B) shows the displays when the incoming speed is faster than required. Figure 1-45 (C) shows the displays when the incoming speed is slower than the normal requirements.

The most common cause of speed distortion is a maladjusted motor-governor. This distortion also can be caused, however, by slipping clutches or varying oscillator frequencies in electronic distributors.

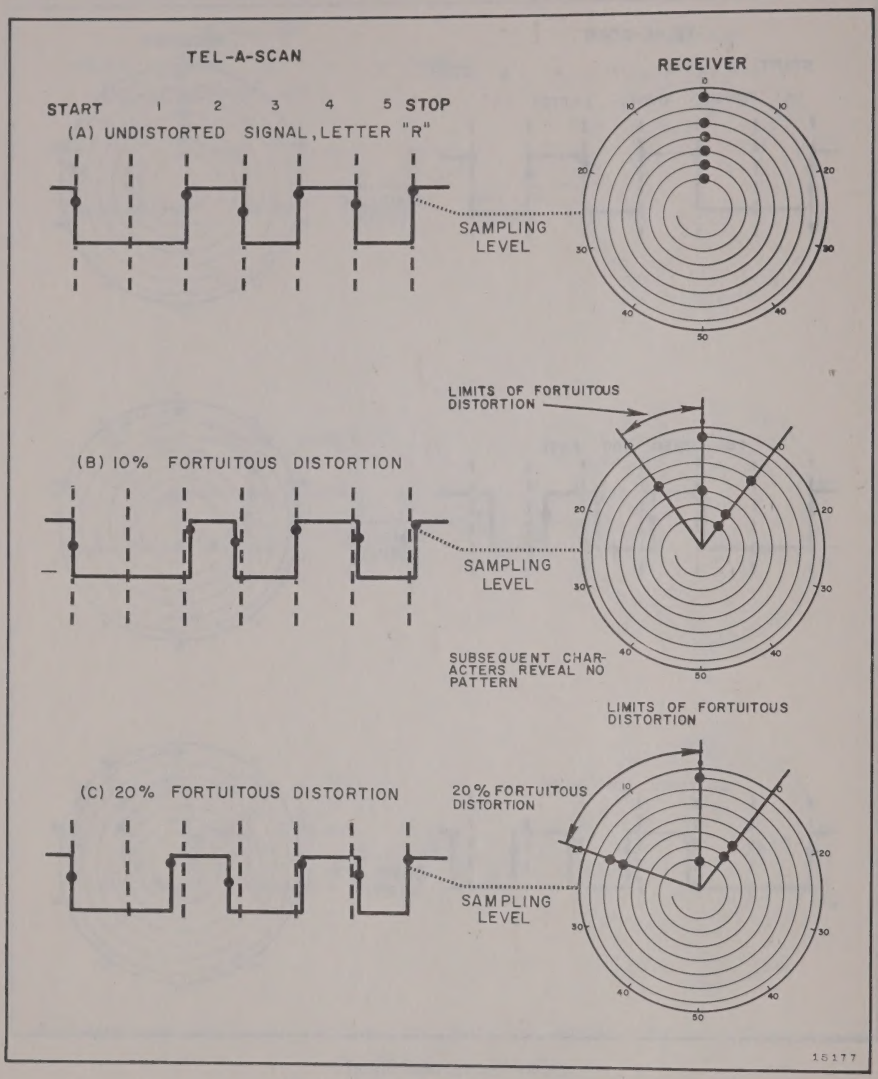


Figure 1-46. Fortuitous Distortion

(c) Fortuitous Distortion

Fortuitous distortion is a random displacement, splitting, and/or breaking up of the mark and space elements. The most distinctive feature of fortuitous distortion is the complete absence of pattern.

Figure 1-46 (A) shows the TDMS Receiver and Tel-A-Scan displays of a normal signal for the letter "R". Figure 1-46 (B) shows the letter "R" containing 10 percent fortuitous distortion. Figure 1-46 (C) shows the same characteristic when 20 percent fortuitous distortion is present.

Momentary battery fluctuations, poorly soldered joints, dirty keying contacts, and similar random disturbances result in fortuitous (patternless) distortion.

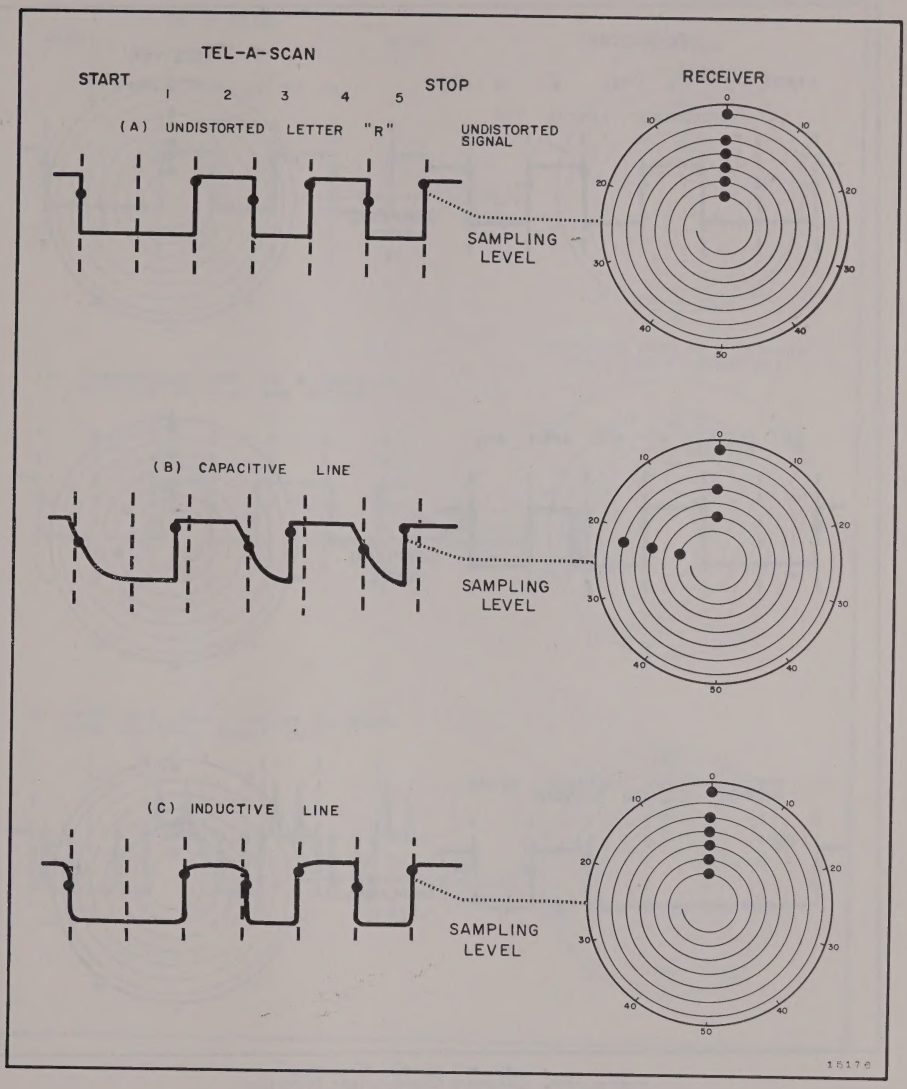


Figure 1-47. Line Characteristic Distortion

(d) Line Characteristic Distortion

Line characteristic distortion is, basically, the distortion caused when the length of the received signal impulses is affected by the presence of changing current transitions in wire circuits. The amount of line characteristic distortion is dependent upon the magnitude of the fluctuation.

Figure 1-47 (A) shows the normal display on the TDMS Receiver and Tel-A-Scan units for the character "R". Figure 1-47 (B) shows the display presented when the line being analyzed is capacitive. Figure 1-47 (C) shows the displays when the line being analyzed is inductive.

Improperly installed or deteriorated lines can cause line characteristic distortion.

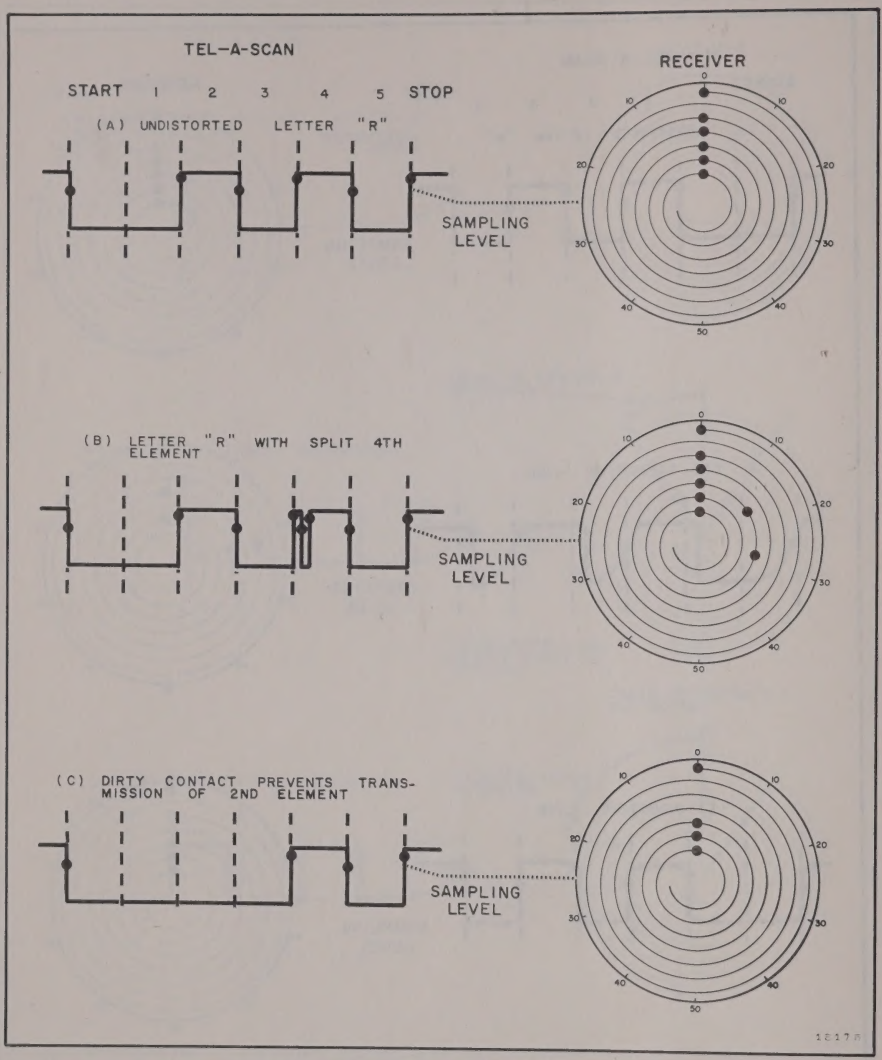


Figure 1-48. Equipment Characteristic Distortion

(e) Equipment Characteristic Distortion

This distortion can take any form within the capabilities of the equipment involved. It is, however, repetitive in nature.

Figure 1-48 (A) shows the normal display on the TDMS Receiver and Tel-A-Scan units for the character "R". Figure 1-48 (B) shows reception of the letter "R" with a split fourth element. Figure 1-48 (C) shows the display seen when dirty transmitting contacts prevent transmission of the second element. The receiving equipment would, in this case, cause a carriage return.

The split elements illustrated could be caused by dirty relay contacts. The missing second element could be caused by a dirty distributor head.

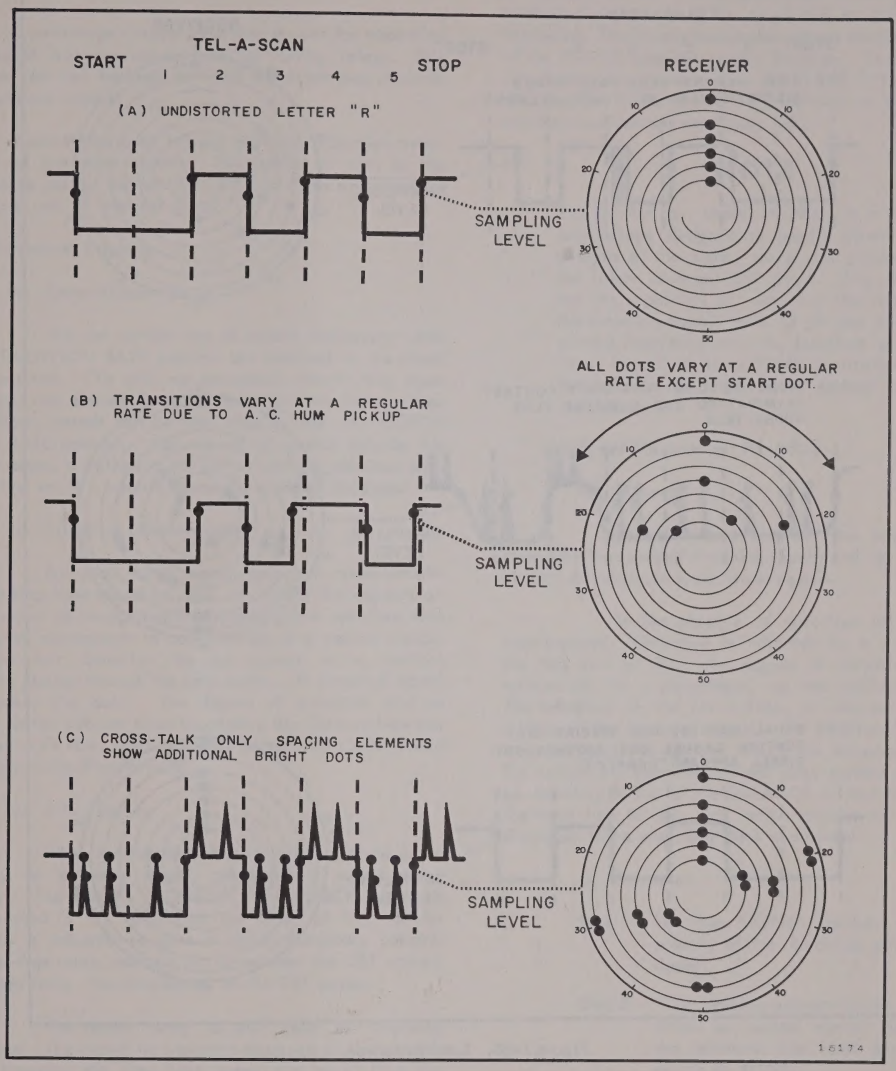


Figure 1-49. Cyclic Distortion

(f) Cyclic Distortion

This distortion is not characteristic, bias, or ortuitous distortion, though it may resemble any of these ypes. In general, it has a periodic nature.

Figure 1-49 (A) shows the normal display of he letter "R". Figure 1-49 (B) shows the letter "R" when ac hum is present in the circuit. Figure 1-49 (C) shows the letter "R" when unfiltered square wave signalling is picked up from adjacent lines.

The most common cause of cyclic distortion is ac hum on teletype circuits which, in turn, is caused by poor filtering in the power supplies. Crosstalk is usually the source of the condition displayed in Figure 1-49 (C).

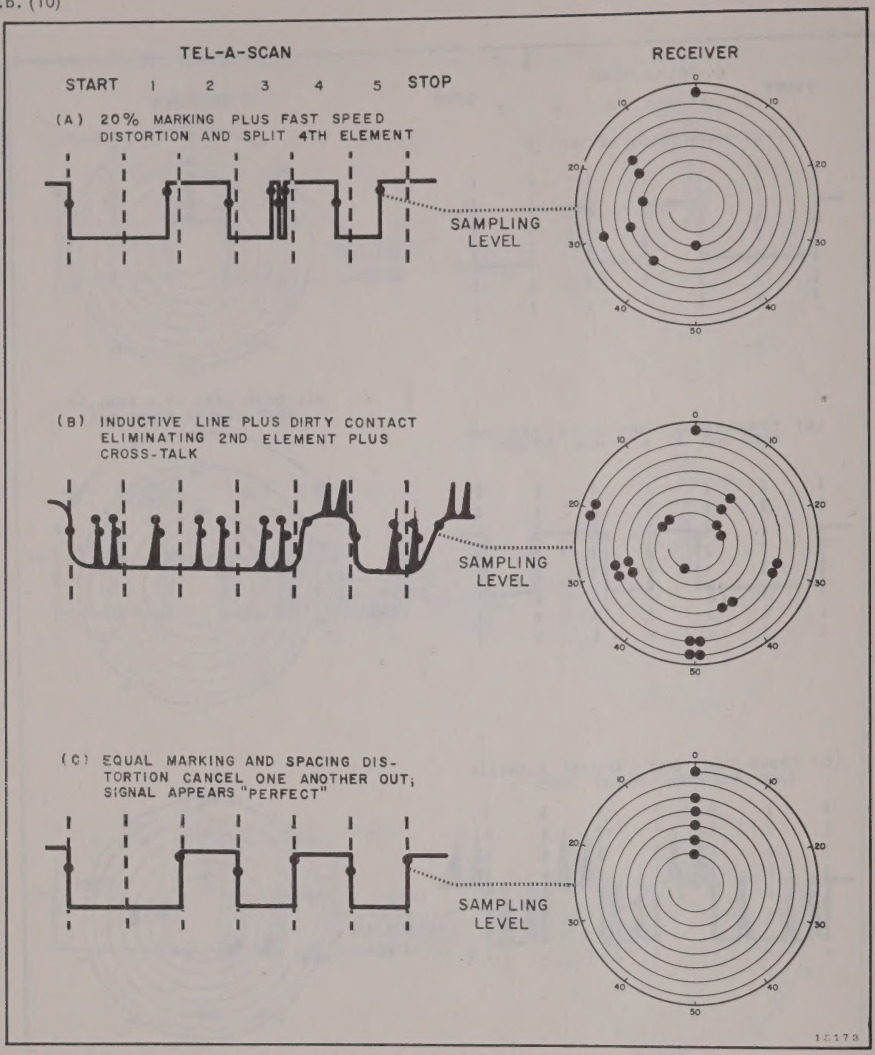


Figure 1-50. Total Distortion

(g) Total Distortion

This is the cumulative total of all forms of signal distortion. For instance, a signal having marking bias in one link of a telegraph system and spacing bias in another portion could actually have less bias at the termination than at other points in the system due to the cancelling effect of the two opposite types of distortion.

The distortion shown in Figure 1-44 (B), 1-45 (B) and 1-48 (B) will result in the total distortion displayed by Figure 1-50 (A). The distortion shown in Figure 1-47 (C), 1-48 (C), and 1-49 (C) will result in the total distortion shown in Figure 1-50 (B). The distortion shown by Figure 1-44 (B) and (C) will result in the undistorted display shown in Figure 1-50 (C).

(10) Circular Trace Applications

When checking signals other than start-stop, the Receiver can be used for speed checks by the ratio method (see Figure 1-25). The oscillator is slaved to an outside source and the RANGE and VERNIER controls are set to correspond to the approximate frequency. The distortion shown on the circular trace is then measured by reading the distance between any two or more dots on the percentage scale printed on the CRT (Figure 1-26). If the double-dot method is being used (1:2 ratio) the percentage must be multiplied by two, etc.

(11) Time Bases

A continuous circular time base is used for measuring the speed of incoming signals and for testing relays. This time base can also be used for total distortion measurements of synchronous signals.

A spiral time base is used for total distortion measurements of start-stop signals. The number of turns on the spiral can be set by the UNIT CODE switch to accommodate the various unit or element codes.

(12) Receiver Displays

(a) Speed Measurements

The dot pattern should remain stationary when the MODULATION RATE controls are matched to the speed being measured. This will not necessarily remain true when a fractional stop element is used: the spiral time base is then used. Signal speeds can be read directly from the MODULATION RATE controls. For signals at speeds outside the Receiver range, a stationary dot pattern can be obtained with the Receiver set to a submultiple of the speed of the signal.

(b) Distortion Measurements

For start - stop signal distortion measurements the spiral time base should be used. A bright dot appears on the transition of each signal element. One complete turn on the spiral corresponds to one element of a perfect signal; hence, for zero distortion the dots appear on a vertical radial line passing through the zero point. A distorted signal will displace the dots. The degree of distortion can be detected on the circular trace by reading the distance between any two or more dots, relative to the percentage scale around the CRT graticule (Figure 1-26).

(c) Relay Testing

When testing for bias, the relay must be energized by an external signal, preferably a square wave generator. The MARK, TONGUE, and SPACE terminals are connected to the relay and the speed of the circular time base is adjusted to give a single stationary pattern. For a bias-free relay, a single dot appears on the CRT screen; for a biased relay, two dots appear on the CRT screen.

The above setup is also used for checking transit time. The transit time appears as an arc on the circular trace. Knowing the time base speed, the transit time can easily be evaluated and expressed as a percentage of a given baud rate.

Contact bounce is observed as a bright dot or arc detached from the principal (transit-time) arc.

(13) External Oscilloscope

The external oscilloscope used in place of the A-scan display should have a linear time base sufficiently slow to accommodate a whole character at the signalling speed in use. It also must have a vertical deflection system capable of displaying a square wave the length of several character elements without appreciable distortion. Intensity modulation (Z-modulation) must also be available for 100-volt input pulses. Input impedance must be at least one megohm, particularly for the Z-axis modulation circuit. The vertical deflection system should be connected to the signal being monitored. The Z-axis modulation circuit should be connected to the Z-AXIS terminal on the Receiver. The synchronizing circuit should be connected to the SCOPE SYNC terminal on the Receiver. For TDMS interconnections when using an auxiliary oscilloscope see Figure 1-21.

NOTE

The Tel-A-Scan, Model 14-200B, is a versatile oscilloscope designed to permit direct visual analysis of the signal waveforms presented by the linear (A-scan) CRT trace. This unit also has the capability of measuring the voltage of the incoming signal, with 10 percent accuracy, without interfering with the waveform presentation. In addition to its TDMS applications, the Tel-A-Scan can serve as a general purpose oscilloscope.

(14) Speed Measurement Procedure

(a) General

The continuous circular time base is used for measuring the speed of incoming signals and for the measuring of total distortion on synchronous signals.

In the absence of distortion all the dots are superimposed. Distortion is indicated by a displacement of the dots over an arc; the degree of distortion is directly measurable, as a percentage, on the calibrated graticule. The waveform on the Tel-A-Scan, or external oscilloscope, is that of the incoming signal. The brightened spots on this trace indicate the point at which the Receiver is triggered. For neutral and balanced current polar systems this point can be varied by means of the BALANCE control associated with the input line in use. This action enables the nature of the distortion to be analyzed more accurately.

(b) Procedure

Step 1 Set the SIGNAL switch at the mark polarity of the incoming polar or neutral signal.

Step 2 If no voltage appears in the marking condition on neutral current keying, remove the left-hand dust cover and set KEYING switch to REVERSE.

Step 3 Set the DISPLAY switch to BOTH.

Step 4 Set the RANGE switch to the position nearest the speed of the incoming signal. One or more dots should appear on the circular trace.

Step 5 If no dots appear, adjust the BALANCE control corresponding to the line in use until the dots are clearly visible.

Step 6 Adjust the VERNIER control until the dot(s) is stationary; the speed of the incoming signal, in bauds, can now be read directly from the RANGE and VERNIER settings.

NOTE

With some types of asynchronous signals, it may be impossible to set the speed of the time base on the circular trace. The spiral trace method must then be used.

(15) Distortion Measurement Procedure

(a) General

By means of the triggered spiral time base, either synchronous or asynchronous signals can be observed. Unlike the circular time base, the spiral time base does not function unless triggered by an incoming signal. It then performs a complete spiral and stops until again triggered. By first setting the speed of the time base so that one turn of the spiral is equivalent to one character element of the incoming signal, each character element can be seen separately. Since the time base starts only when triggered, it is unnecessary for the incoming signal to be continuous and evenly spaced in time; each character starts the time base in synchronism with itself.

NOTE

For distortion measurement using the circular time base (asynchronous signals) refer to Paragraph 4 b (14).

(b) Procedure

Step 1 Perform the procedures outlined in Paragraphs 4b(7) and 4b(12) and set UNIT CODE switch to the position which will accommodate the signal being monitored (for example: set at 7 for a five-unit, start-stop element code).

Step 2 Set TIME BASE switch to SPIRAL.

NOTE

Only minor adjustment of the AMPLITUDE control can be made after setting the TIME BASE switch at SPIRAL. If large adjustments are made after switchover, the spiral trace may collapse. It will then be necessary to switch back to CIRCULAR to re-establish the trace.

(c) Discussion

A spiral display should now appear on the screen. Dots will appear on this display at positions corresponding to the times of the mark/space changeovers. Any difference in speed between the time base and the incoming signal is indicated by displacement of the dots from a vertical line. The dot indicating the last changeover is the most displaced, and the intermediate dots are displaced in progressive proportion (Figure 1-45).

With some types of asynchronous signals, it may be impossible to set the speed of the time base by use of the circular trace. If so, the spiral trace method can be used. Adjust the VERNIER control to minimize any proportional displacement while using the spiral trace.

Distortion is now indicated by a displacement of the dots. This distortion cannot be corrected by readjustment of the VERNIER control. For example, distortion due to a long start element will cause all the dots (except the start element dot at the beginning of the trace) to be equally displaced to the right side of the vertical. An attempt to correct this effect by adjustment of the VERNIER control can only result in spacing the dots to either side of the vertical in an irregular manner.

With experience, the differences between displacement of the dots due to incorrect setting of the VERNIER control, and displacement distortion of the signal, becomes obvious. When the speed of the time base is accurately set by use of the circular trace, the possibility of misinterpretation is avoided.

The degree of distortion is read at two-percent per division on the engraved graticule of the CRT. Each individual changeover may be separately seen and recognized, and the degree of distortion of individual elements separately measured.

Mark/space and space/mark changeovers may be separately selected by use of the DISPLAY switch.

When displaying continuous signals, the spiral time base can be triggered by a character element of the signal instead of the start element. Correction can be made by momentary disconnection of the incoming signal. This cannot happen on hand-sent signals since the time base will automatically synchronize itself to the start element.

(16) Relay Test Procedures

(a) Bias

Step 1 Connect the relay tongue to the terminal marked TONGUE. Connect the mark and space contacts to the MARK and SPACE terminals.

Step 2 Set the SIGNAL switch to BIAS.

NOTE

The relay under test must be energized by a suitable external signal source such as a 25 cps square wave generator. The external source must be connected directly to the relay coils.

Step 3 Set the TIME BASE switch to CIRCULAR.

Step 4 Set the DISPLAY switch to BOTH.

Step 5 Set RANGE and VERNIER controls to twice the speed of the signal source; for example, to 50 bauds if using a 25 cps source.

Step 6 Adjust the relay until the tongue vibrates. One or more dots should appear on the circular trace. The relay is correctly adjusted for zero bias when adjustment causes the dots to coincide.

NOTE

Adjust relay for approximately two mils spacing (one mil for each contact).

To adjust the bias, the two contacts must be adjusted in opposite directions until the two dots are superimposed (i.e., if the MARK contact spacing is decreased, the SPACE contact spacing must be increased by an equal amount). The direction of adjustment necessary must be determined experimentally. This adjustment should be made in small steps until the dots are superimposed.

(b) Transit Time

After setting the SIGNAL switch to TRANSIT ME, transit time, or time between contacts is shown as a ight arc on the trace. Transit time percentage of total perating time is again read directly from the graticule scale.

NOTE

Transit times in each direction are shown as superimposed traces; therefore, the CRT reading is not accurate until the relay has first been adjusted for bias.

Actual transit time and contact time can now be mputed. At the 50-baud speed, each character element is med for 20 milliseconds. An arc showing transit time of five ercent will represent five percent of 20 milliseconds, or ne millisecond.

Step 1 With the instrument operating as above for measurement of transit time, observe the end of the bright arc on the trace. If contact bounce is present, it will be indicated by one or more breaks and dots of this arc.

Step 2 Transit time is adjusted by adjusting both contacts in the same direction in equal amounts to keep the two arcs superimposed. Decreasing the spacing of both contacts shortens the transit time. Increasing the spacing lengthens the transit time. The transit time should be adjusted for minimum contact bounce and shortest transit time indication, while keeping sufficient contact spacing. Recheck the bias adjustment and reset if necessary.

NOTE

If either BIAS or TRANSIT TIME is readjusted, the other adjustments should be rechecked for interaction.

(17) Tel-A-Scan Functional Operation

The Tel-A-Scan, a special purpose oscilloscope, resents a linear (A-Scan) display of telegraph signals; the arious forms of distortion can be analyzed and the amplitude of their waveforms measured. When powered with the Rack-Mount or Portable Power Supply and interconnected with the Receiver, the triggering point (sampling level) of the Receiver can be accurately determined by the dots superimposed on the waveform; the two displays can thus be analyzed simultaneously, increasing their value.

Correct operation of a teleprinter or other data recording device is not conclusive evidence that degrading distortion is not present. It is obviously preferable to detect, measure, and analyze such distortion without taking a telegraphic or data system channel out of service. This the Tel-A-Scan does. It can detect distortion and determine its nature and probable cause even when it is impossible to determine message errors, such as those occurring when cryptograms or data code groups are being transmitted. Once the nature of the distortion is known, it is often possible to correct the fault before a link becomes unserviceable. Distortion caused by a maladjusted relay, for example, can be corrected without interrupting the flow of traffic for appreciable time. Even when distortion is induced by a cause beyond the control or diagnostic ability of a non-technical operator, with a little preliminary briefing he can tell when a circuit is deteriorating and when the distortion is exceeding the margin acceptable at any given receiving terminal.

(18) Description of Tel-A-Scan Controls

Table IX lists and describes the function of the potentiometers (R), switches (S), and indicators (I) located on the front panel of the Tel-A-Scan. These controls and indicators are shown in Figure 1-51. Table X describes the internal controls which are shown in Figures 1-52 and 1-53.

TABLE IX. TEL-A-SCAN FRONT PANEL CONTROLS AND INDICATORS (Figure 1-51)

CONTROL	FUNCTION
PWR OFF (S756)	A two-position rotary switch actuated by the clockwise rotation of the INTENSITY control. In the "on" position, it applies ac power to the power supply. In the PWR OFF position, it disconnects ac power from the power supply.
POWER (I-1)	A red lamp which lights when ac power is applied.
INTENSITY (R824)	A knob-controlled potentiometer which controls the brightness of the trace on the CRT screen.
FOCUS (R826)	A knob-controlled potentiometer which controls the sharpness of the trace on the CRT screen.
VERT POS (R726)	A knob-controlled potentiometer which controls the up-and-down positioning of the CRT display.
HORIZ POS (R779)	A knob-controlled potentiometer which controls the positioning of the CRT display to the right or left.

TABLE IX. TEL-A-SCAN FRONT PANEL CONTROLS AND INDICATORS (Continued) (Figure 1-51)

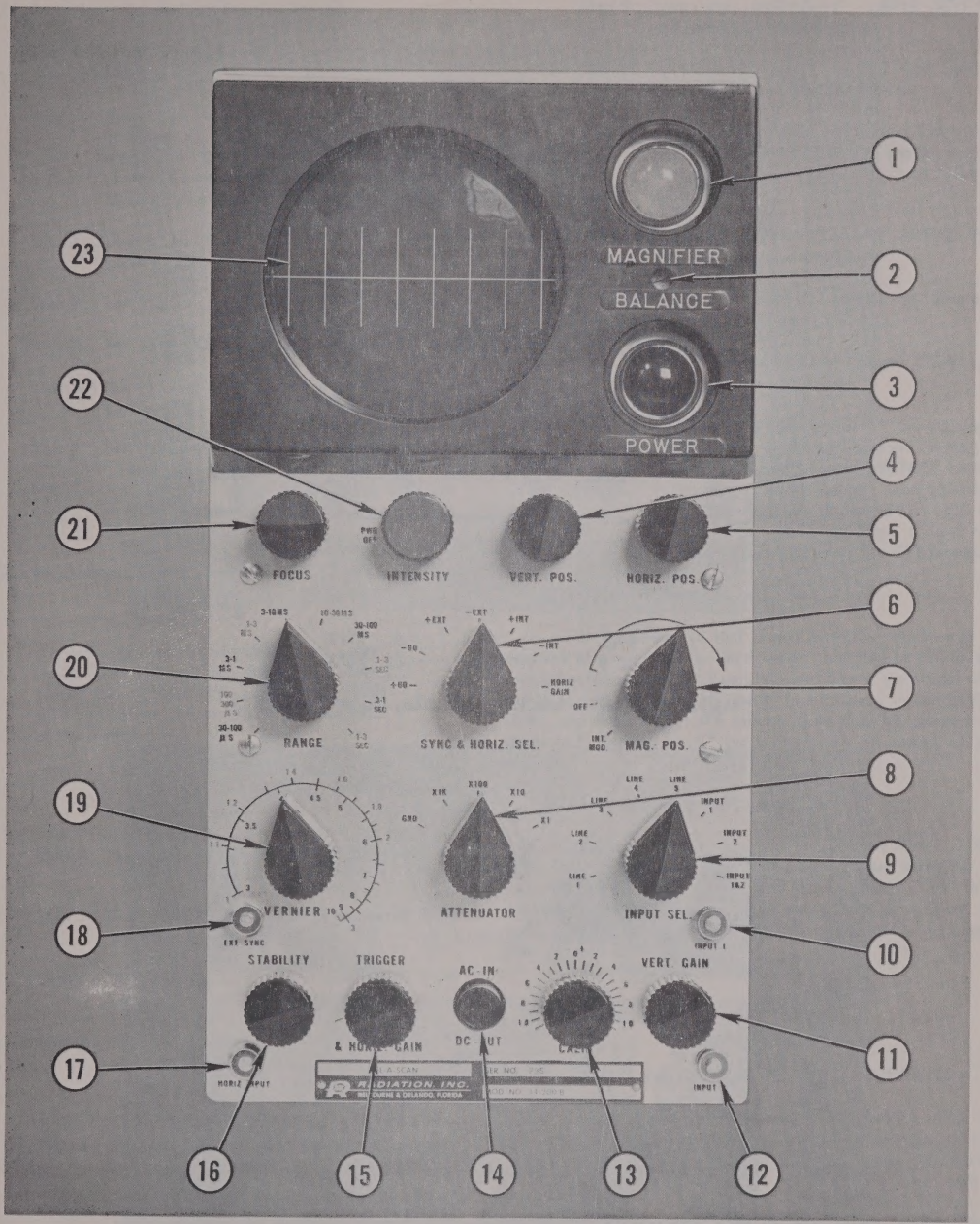
CONTROL	FUNCTION
RANGE (S755)	An 11-position switch that controls the speed of the horizontal sweep.
VERNIER (R760)	A knob-controlled potentiometer which controls the speed of the horizontal sweep within the various ranges of the RANGE switch. The two scales of this control are colored red and black. The red scale is used with the RANGE switch positions colored red, and the black scale is used with the RANGE switch positions colored black.
SYNC & HORIZ SEL (S753)	A seven-position switch that selects the synchronization mode. In the HORIZ GAIN position it connects the HORIZ INPUT connector (front panel) to the horizontal amplifier.
MAG POS (S754 and R773)	A three-position switch with gain potentiometer. 1. INT MOD - When in this position the Z-axis signal applied to terminal 11 on the power supply modulates the trace. 2. OFF - This position turns off both the magnifier and Z-axis modulation. 3. Further rotation of the knob selects the position of the magnified trace.
STABILITY (R751)	A knob-controlled potentiometer which controls the stability of the time base generator.
TRIGGER HORIZ GAIN	A knob-controlled potentiometer which controls the amplitude of the synchronizing pulse applied to the time base generator. When the SYNC & HORIZ SEL switch is in the HORIZ GAIN position, this control regulates the amplitude of the signal applied to the horizontal amplifier from the HORIZ INPUT connector.
INPUT SEL (S750)	An eight-position switch which selects the vertical input signal to be displayed.
ATTENUATOR (S752)	A five-position switch which controls the amplitude of the input signal applied to the vertical amplifiers.
VERT GAIN (R716)	A knob-controlled potentiometer used to vary the gain of the vertical amplifiers.

TABLE IX. TEL-A-SCAN FRONT PANEL CONTROLS AND INDICATORS (Continued) (Figure 1-51)

CONTROL	FUNCTION
MAGNIFIER (I-2)	A white lamp that lights when the magnifier control is rotated to the positioning area.
CALIB (R815)	A knob-controlled potentiometer which controls the position of the calibrate retrace. In its CCW position this control operates a switch that turns off the calibrator and activates the retrace blanking circuits.
AC-IN/DC-OUT (S751)	A pushbutton switch used to connect a capacitor in series with the vertical input to block any dc voltage present.
BALANCE (R719)	A potentiometer used to control the dc balance of the vertical amplifier.

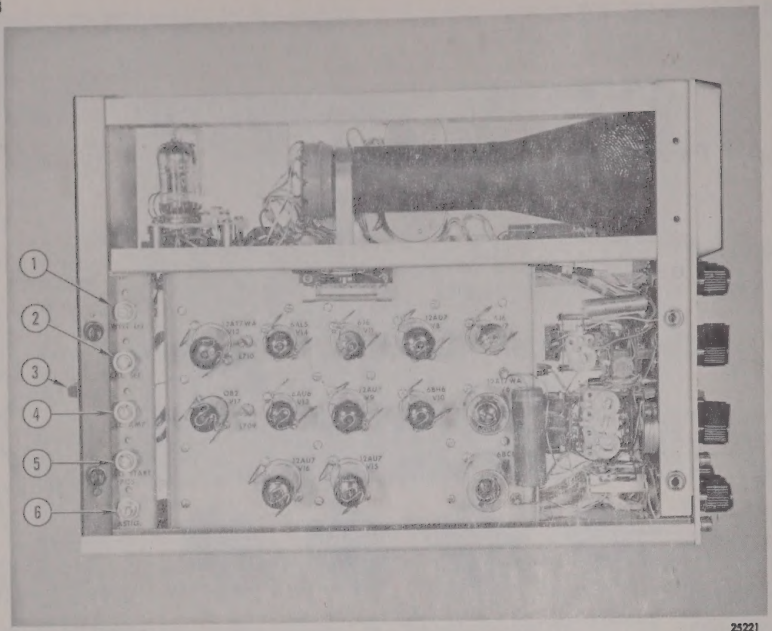
TABLE X. TEL-A-SCAN INTERNAL CONTROLS (Figures 1-52, 1-53)

CONTROL	FUNCTION
NOTE The following controls are located under the dust covers on each side of the instrument: The first five are located on the left-side rear; the last four are on the right-side top center.	
SWEEP LG (R786)	Controls the length of the horizontal trace.
CAL SET (R818)	Adjusts the registration of the calibrator.
CAL AMP (R805)	Adjusts the amplitude of the calibrator pulse applied to the vertical amplifier.
MAG START POS (R777)	Sets the position at which the magnifier sweep starts.
ASTIG (R823)	Used in conjunction with the FOCUS control to vary the sharpness of the display.
SWEEP CAL 1 (R759)	Sets the range of VERNIER control at the CCW end of its rotation.
SWEEP CAL 2 (R761)	Sets the range of VERNIER control at the CW end of its rotation.
1ST AMP BIAS (R772)	Sets the bias of the first vertical amplifier.



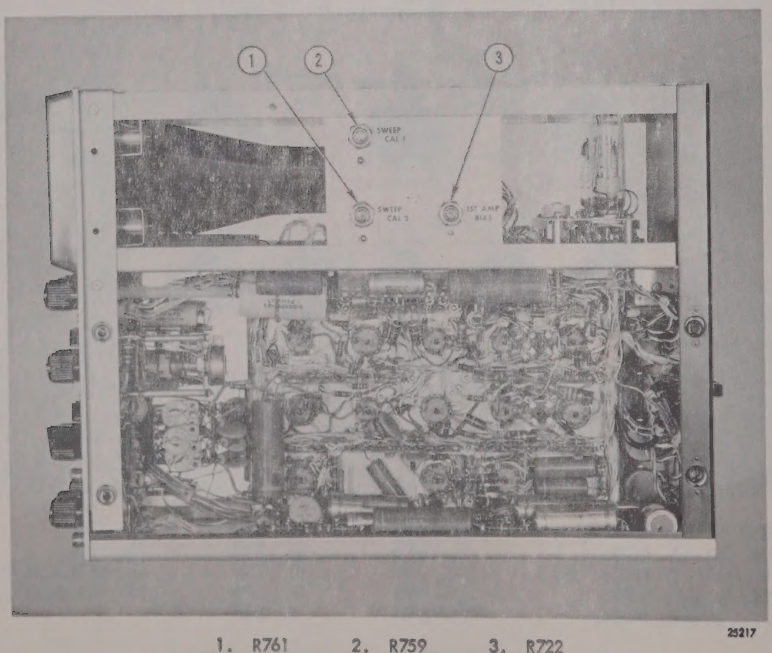
1. I-2
2. R719
3. I-1
4. R726
5. R779
6. S753
7. R773 and S754
8. S752
9. S750
10. J701
11. R716
12. J702
13. R815
14. S751
15. R744
16. R751
17. J703
18. J704
19. R760
20. S755
21. R826
22. R824 and S756
23. CRT GRATICULE

Figure 1-51. Tel-A-Scan Unit - Front Control Panels



1. R786
2. R818
3. P701
4. R805
5. R777
6. R823

Figure 1-52. Tel-A-Scan Unit, Left Side, Cover Removed



1. R761
2. R759
3. R722

Figure 1-53. Tel-A-Scan Unit, Right Side, Cover Removed

(19) Preliminary Tel-A-Scan Starting Procedure

The following steps should be performed before rating the Tel-A-Scan:

Step 1 Make sure that the Tel-A-Scan is firmly attached to the Portable Power Supply, Model 14-104B, or firmly inserted in one of the available compartments of Rack-Mount Power Supply, Model 14-102/103D.

Step 2 Check all input connections for proper hookup.

Step 3 Set FOCUS control in its center position.

Step 4 Set VERT POS control in its center position.

Step 5 Set HORIZ POS control in its center position.

Step 6 Set INPUT switch at an appropriate position.

Step 7 Set RANGE and VERNIER controls to positions corresponding to the speed of the incoming signal.

(20) Tel-A-Scan Starting Procedure

NOTE

If any abnormal indications are seen while performing the following steps, place the INTENSITY control at PWR OFF and inform the maintenance specialist of the malfunction.

Step 1 Rotate the INTENSITY control CW until a click is heard. The red POWER indicator should glow.

Step 2 Allow a warm-up interval of about 10 minutes.

Step 3 Turn the STABILITY control to the full CCW position.

Step 4 Turn the TRIGGER control to the full CCW position.

Step 5 Turn the CALIB control to the full CCW position. (When in this position, it actuates the switch which disconnects the calibration circuit and actuates the blanking circuit.)

Step 6 The AC-IN, DC-OUT pushbutton should be in the DC-OUT position.

Step 7 Since the total incoming signal will take 163 milliseconds (with a 60-wpm line) for its presentation, set the RANGE switch to the .1-.3 SEC position.

Step 8 Set the VERNIER control to approximately 1.6. (From the settings of the RANGE and VERNIER controls, an approximation of the time occupied by one character of the incoming signal may be arrived at.)

Step 9 Turn the INTENSITY control CW to approximately its mid-point.

Step 10 Turn the STABILITY control CW until a trace appears on the CRT screen.

Step 11 Position the INPUT ATTENUATOR switch and adjust the VERT GAIN control until a pattern approximately one inch high is obtained.

Step 12 Adjust the VERT POS and HORIZ POS controls to center the trace.

Step 13 Adjust the FOCUS control to obtain a sharp trace.

Step 14 Rotate the STABILITY control CCW until the trace just disappears.

Step 15 Turn the TRIGGER control CW until a stable trace appears on the CRT screen. It may be necessary to readjust the VERNIER control to obtain a stable pattern (one character long). Turn the CALIB control CW until the pointer is at zero. The trace should now show as a second trace on the CRT screen.

(21) Distortion Analysis

It is imperative that undue distortion discovered in one link of a telegraph or data system complex be minimized or eradicated as soon as possible. Ignoring a distortion condition in one link can only result in distortion in succeeding links, and distortion in the several links may be cumulative. Refer to Paragraph 4b (9) for a complete discussion of this subject.

(22) Rack-Mount Power Supply Operation

To energize this supply in conjunction with a TDMS unit, insert one of the units into the compartment wired for it, turn the INTENSITY control (red knob on each TDMS unit) clockwise and permit one minute warm-up. To operate the supply without an associated TDMS unit, place a jumper from pin 5 to pin 17 of J10.

WARNING

VOLTAGES DANGEROUS TO LIFE ARE PRESENT.

Care should be exercised when working with the power cord plugged into an outlet. Line voltage is still present in part of the supply even though the INTENSITY control is turned to PWR OFF, or though the TDMS unit is extracted from the Rack-Mount Power Supply. To remove power completely, the power plug must be removed from the outlet.

(23) Portable Power Supply Operation

To operate this power supply when not connected to a TDMS unit, connect a temporary jumper between pins 5 and 17 of J1. This has the same effect as turning on the INTENSITY control of an attached TDMS unit. Connect a

one megohm resistor from pin 16 of J1 to ground to act as a load for the -800 volt circuit. When working on the supply, remove power plug from the outlet; disconnecting the temporary jumper is not sufficient as line voltage is still present in part of the unit.

5. MAINTENANCE AND TROUBLESHOOTING INSTRUCTIONS

a. Periodic Inspections

(1) Daily

(a) Check general condition of the equipment.

(b) Clean dirt and moisture from jacks and barrier strips.

(c) Inspect seating of readily accessible items such as tubes, fuses and connectors.

(d) Check for normal operation.

(2) Weekly

(a) Inspect cables and wires for cuts, breaks, fraying, deterioration, kinks, and strain.

(b) Inspect for looseness of accessible items such as connectors, transformers, potentiometers, and capacitors.

(c) Check tubes for loose envelopes, cracked bases, and loose contacts.

(d) Inspect fixed capacitors for leaks, bulges, and discoloration.

(e) Inspect resistors for cracks, chipping, blistering, discoloring, or other evidence of overheating.

(f) Inspect terminals of transformers, resistors, and capacitors for loose connections and corrosion.

(g) Check mountings, machine screws and nuts, and terminal boards for mechanical looseness.

(h) Inspect transformers and chokes for overheating.

(i) Check for normal operation.

(j) Check to see that the retaining mechanism in the lower front of each of the unit compartments in the Rack-Mount Power Supply has a very light coat of grease.

b. Preventive Maintenance

(1) Electron Tubes

WARNING

AVOID WORKING ON TUBES IMMEDIATELY AFTER SHUTDOWN. SEVERE BURNS CAN RESULT FROM CONTACT WITH ENVELOPES OF HOT TUBES.

All tubes are accessible for removal when a unit is extracted from the rack-mount accessory and both side covers removed. Remove tubes with a direct pull. Rack tube gently if it does not release easily. Keep jiggling of tubes to a minimum during removal to avoid spreading contacts, especially when extracting the miniature tubes.

Inspect tubes for accumulation of dirt and for loose or corroded pins. Watch for tube envelopes which have broken away from the tube bases. Check to see that socket connections are firm.

Clean tubes with a clean, lint-free, dry cloth. Remove dust and dirt from tube sockets with a sashbrush-type cleaning brush, or compressed air. Tighten all loose hardware at the tube sockets.

(2) Capacitors

WARNING

VOLTAGES DANGEROUS TO LIFE ARE PRESENT. DISCHARGE ALL HIGH-VOLTAGE CAPACITORS BEFORE PERFORMING MAINTENANCE.

Examine terminals of capacitors for corrosion and loose connections. Mountings should be checked carefully to be sure that they are tight. Examine the leads for poor insulation and cracks. Inspect the case of each capacitor for leaks, bulges, and discolorations. Clean the case of the capacitor and dirty or corroded connections.

(3) Resistors

Inspect the coating of all resistors for signs of cracks and chipping, especially at the ends. Examine the bodies of resistors for blisters, discolorations, or other indications of overheating. Look for arcing pits or craters. Inspect leads for corrosion, dirt, or broken strands. Clean resistors with a clean, dry cloth, or with a cloth moistened in cleaning solvent. Tighten loose connections and mountings.

(4) Switches and Potentiometers

Inspect the mechanical action of each part and look for signs of dirt or corrosion on any exposed surface. Clean the exterior surfaces of the parts with a stiff brush moistened with a cleaning solvent and polish with a dry cloth. Tighten loose mounting and connecting screws and nuts. If it is necessary to remove wires to tighten loose parts, note the position of the wires so that they may be restored to their original positions.

(5) Terminal Boards

Inspect terminal boards for cracks, breakage, dirt, and loose connections or mounting screws. Clean terminal boards with a dry, sashbrush-type cleaning brush. Tighten loose screws, lugs and mounting bolts. Loose connectors should be removed and cleaned before tightening.

(6) Cables, Receptacles, and Jacks

Inspect cables for cracked, frayed, or deteriorated insulation. Inspect receptacles, plugs, and jacks for dirt

or corrosion. Clean plugs and receptacles with a sashbrush-type cleaning brush dipped in cleaning solvent and dry them thoroughly with a clean cloth. Tighten loose cable clamps, and the mounting screws of receptacles.

(7) Indicator Lamps

To replace indicator lamps, first remove the jewel of the light fixture. Then remove the light bulb by pushing in slightly, turning CCW, and pulling out.

c. Troubleshooting

(1) Transmitter

(a) Figures and Tables

Figure 1-54	Transmitter Block Diagram
Figure 1-55	Transmitter Schematic
Figure 1-56	Transmitter Waveforms
Figure 1-61	Operation Test Waveforms
Figures 2-1 through 2-23, Section II	
Table XI	Troubles and Probable Solutions
Table XII	Transmitter Resistance Chart
Table XIII	Transmitter Voltage Chart

(b) Tools and Equipment

Electronic Tool Kit
Tube Puller
Brush, stiff bristle (non-metallic)
Multimeter (20,000 ohms per volt)
Oscilloscope
Signal Generator (audio)
Electronic Counter (or other frequency measuring device)
Tension Gauge
Feeler Gauge

(c) Transmitter Block Diagram Discussion

Figure 1-54, Transmitter block diagram, and Figure 1-55, Transmitter schematic, are the reference drawings for the following discussions.

(d) Conditions of Operation

An impedance switch is provided for selecting either high or low input impedance. Input signals are fed through an isolation stage of unity gain which converts them to ground-referenced polar signals acceptable to the input amplifier. All input signals are amplified and passed through a double inverter circuit producing signals of negative polarity for the CRT display amplifier regardless of the polarity of the input signal. This tube is normally conducting and is cut off by each transition in polarity of the input. The resulting rise in plate potential causes the CRT to increase in brightness; each transition appears on the CRT as a bright spot on the circular trace. Distortion is measured by comparing the angular positions of consecutive dots; in the absence of distortion, all dots are superimposed.

(e) Circular Sweep

The circular sweep is generated by a local sine wave oscillator and two push-pull driver stages. The sweep voltages to the CRT deflection plates are 90 degrees out of phase, resulting in a circular trace. The RANGE switch and VERNIER potentiometer, respectively, provide coarse and fine control of the oscillator frequency. An external sync signal may be used to synchronize the oscillator with the sync signal. A neon lamp, when strobed with a tuning fork, indicates the speed of the internal oscillator.

The oscillator and push-pull amplifiers supply the circular sweep. The sine wave output of the oscillator is fed to a squarer circuit where it is amplified and clipped to provide an approximate square wave (Figure 1-56). The negative-going edges of the square wave pass through a diode and trigger the scale-of-two flip-flop. The output of this binary counter drives the ring counter at half the frequency of the oscillator. Thus, the circular sweep makes two complete traces during the time of one count of the counter.

(f) Ring Counter

The ring counter is basically an eight-tube multivibrator; at any given time four adjacent stages of the eight stages conduct and four do not. During a count, one of the four conducting stages stops conducting and one of the non-conducting stages conducts, thus moving the group of four conducting stages around the ring by one stage. This action continues for the full count until the ring is again in its normal condition.

The first tube (V10A, Figure 1-55) in the ring controls the start signal. When the scale-of-two flip-flop pulses this tube it conducts, sending a pulse to the space-control amplifier. Upon receiving the pulse from the first tube in the ring counter the space control amplifier triggers the relay driver flip-flop and a space is sent over the line as a start signal. The relay driver flip-flop is normally in a mark position, causing the output relay to send a continuous mark to the output line; this is the normal or idle condition of the telegraph circuit.

(g) Normal and Distorted Output

When the DISPLAY switch is in the NORMAL OUTPUT position, the distorter is bypassed and the start pulse is sent directly to the space control amplifier. In the DISTORT position, the start pulse from the counter goes through the distorter and the start-space pulse sent over the line can be varied ± 50 percent of its normal length. The pulse to the space control amplifier is no longer taken from the first tube section (V10A) in the ring, but from the fourth tube section (V11B). Because of the circuitry of the ring, the fourth tube provides a positive pulse when the eighth tube conducts. This positive pulse triggers the distorter, a one-shot multivibrator; the trailing edge of its output pulse then triggers the space control amplifier. Since the start space is initiated a full unit before its normal time, adjusting the delay in the one-shot multivibrator permits lengthening or shortening the start space fed over the line.

(h) Output Selector

Once the start space has been sent, each pulse from the scale-of-two flip-flop also triggers the mark-control amplifier, sending a mark to the line. If the space-control amplifier receives a space pulse from the counter, it cancels the mark control amplifier output and a space is sent instead of a mark. The signal transmitted can be

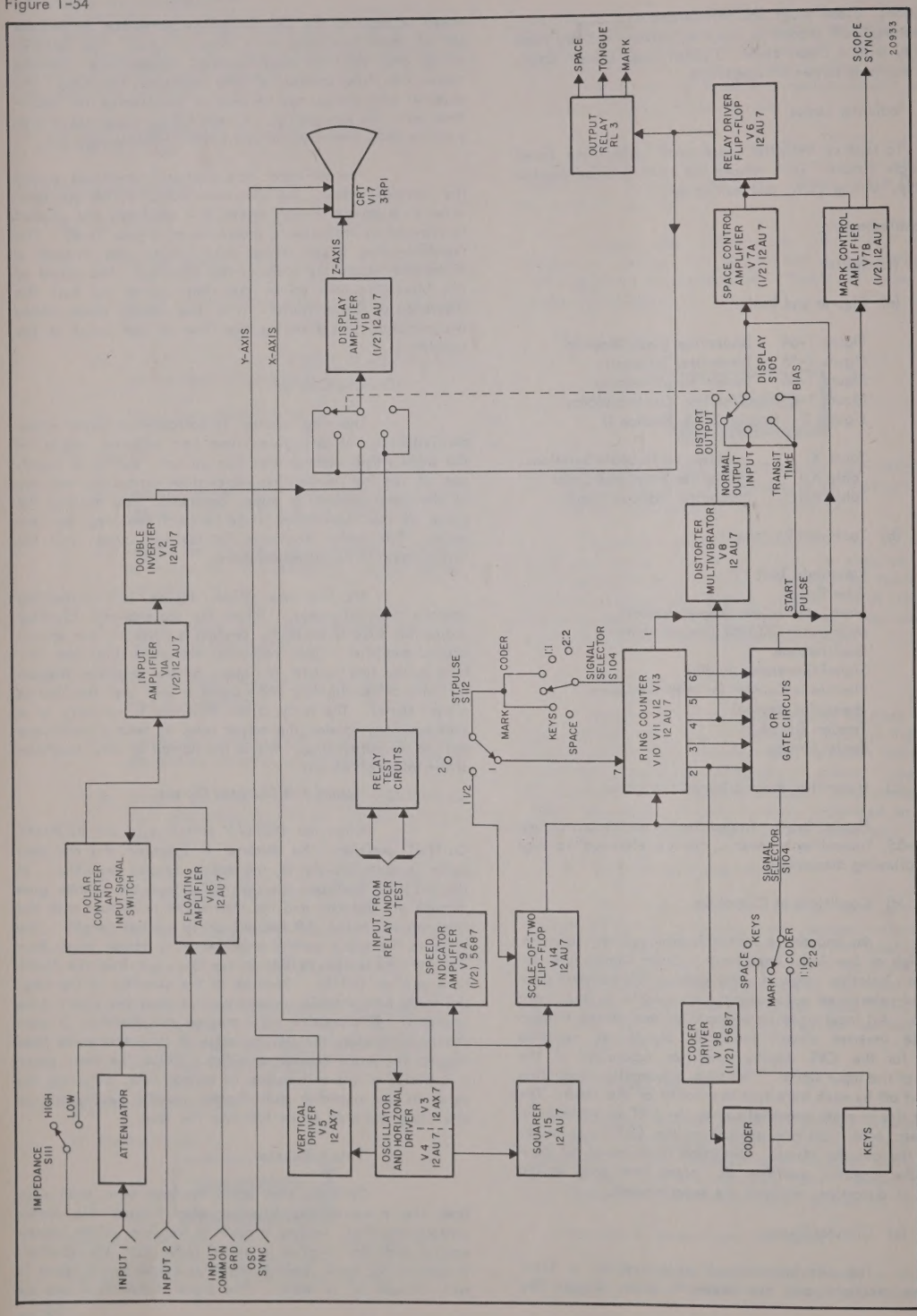


Figure 1-54. Transmitter - Block Diagram

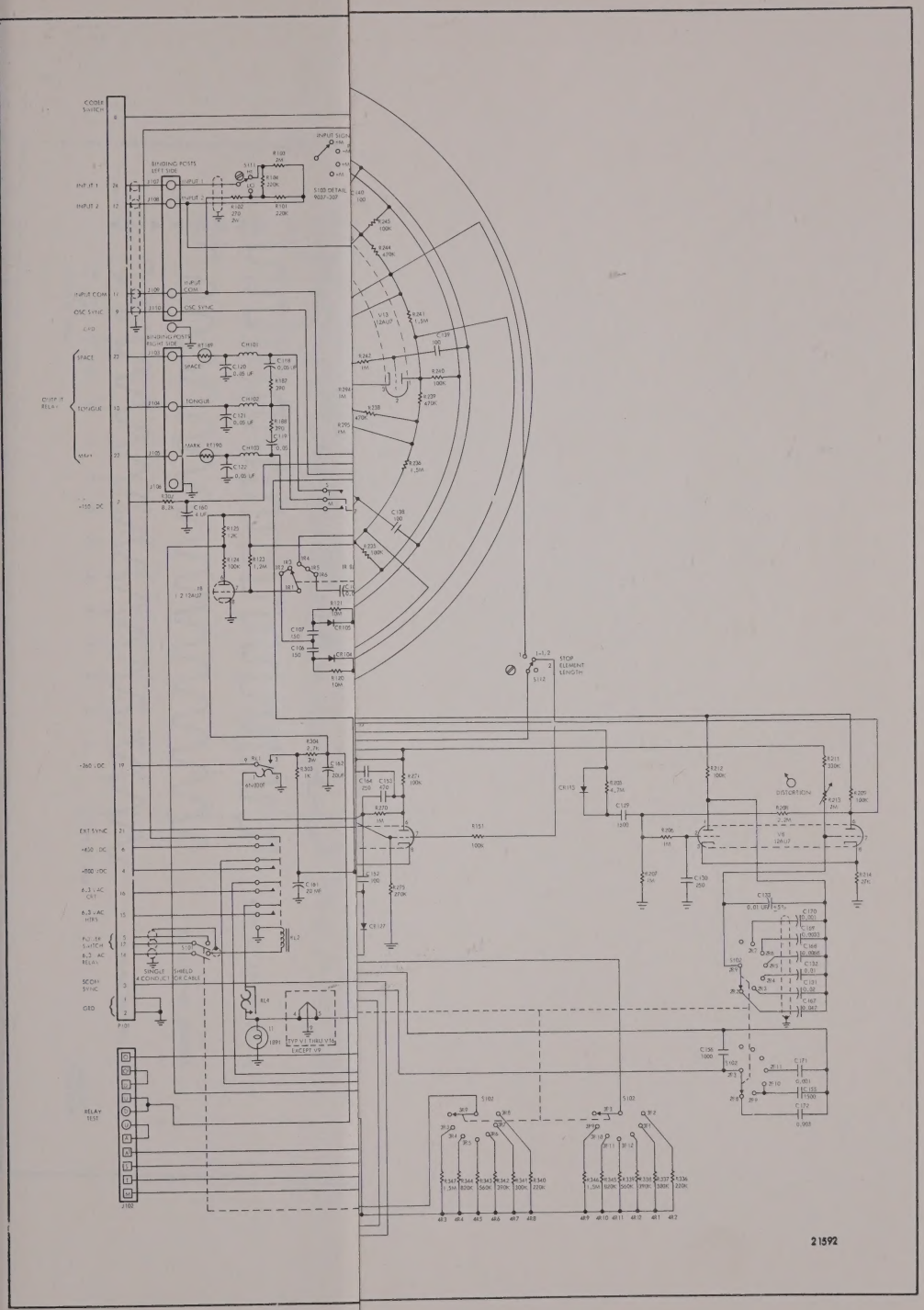


Figure 1-55. Transmitter Schematic

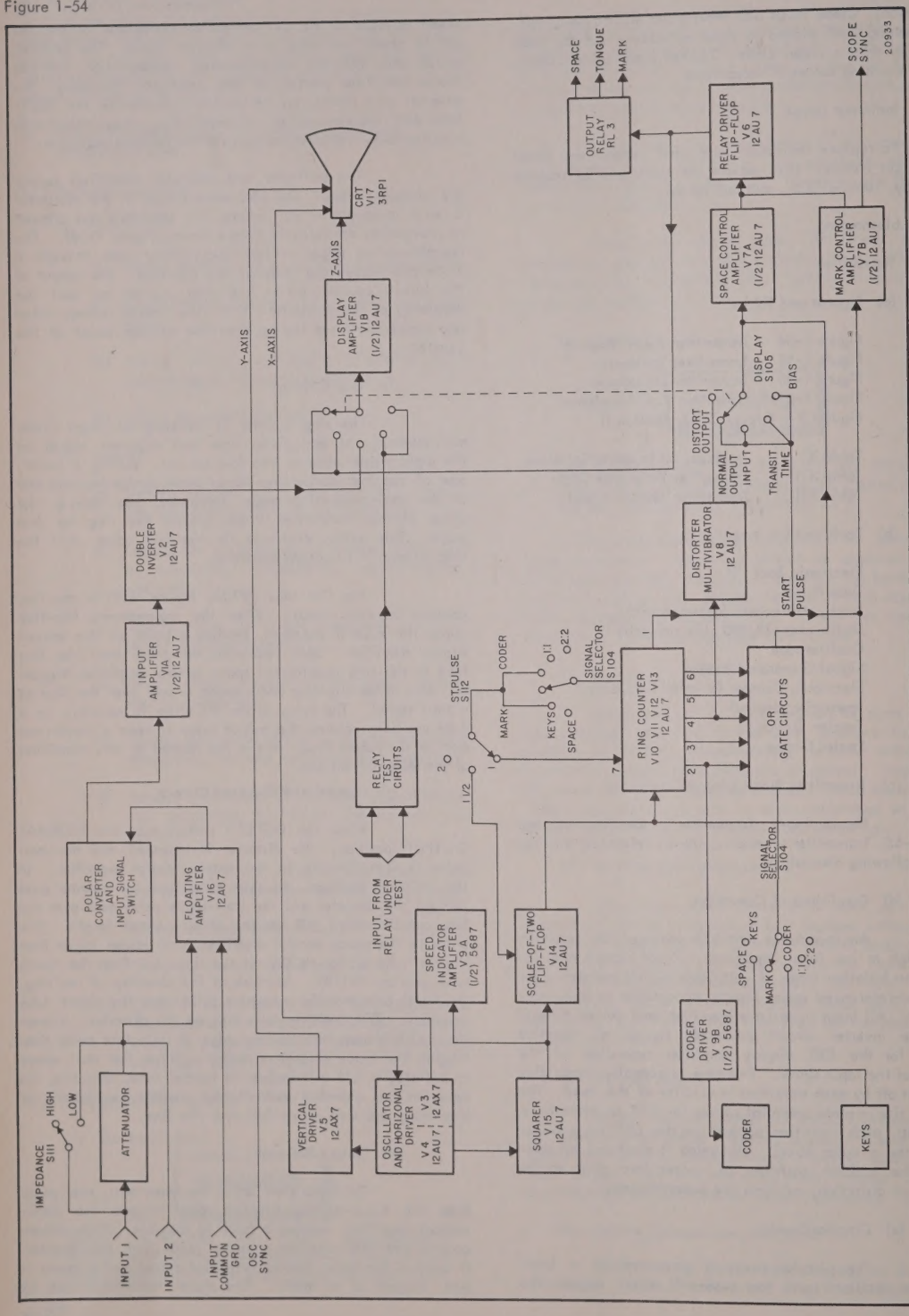


Figure 1-54. Transmitter - Block Diagram

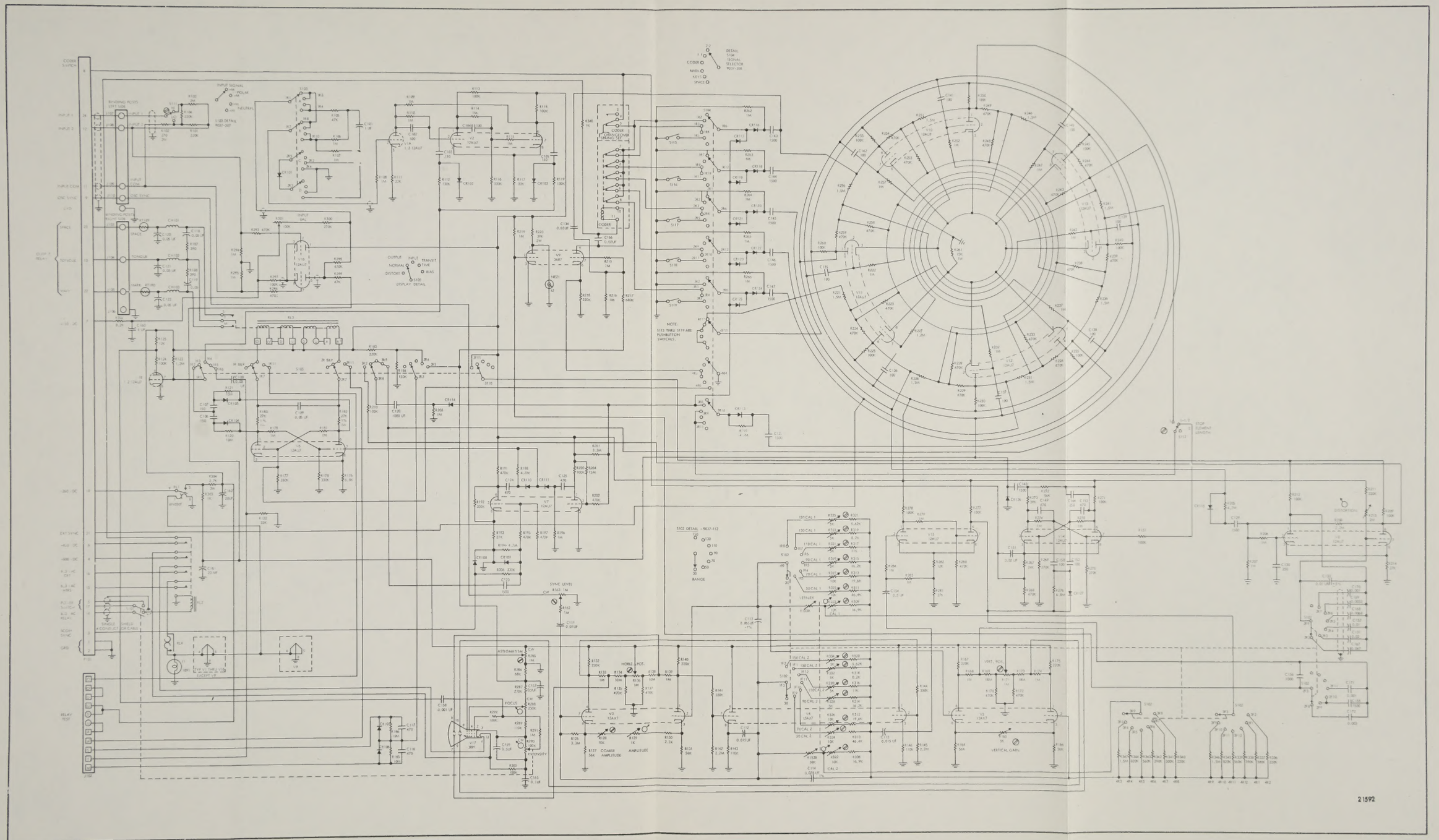


Figure 1-55. Transmitter Schematic

Figure 1-56. Transmitter Waveforms

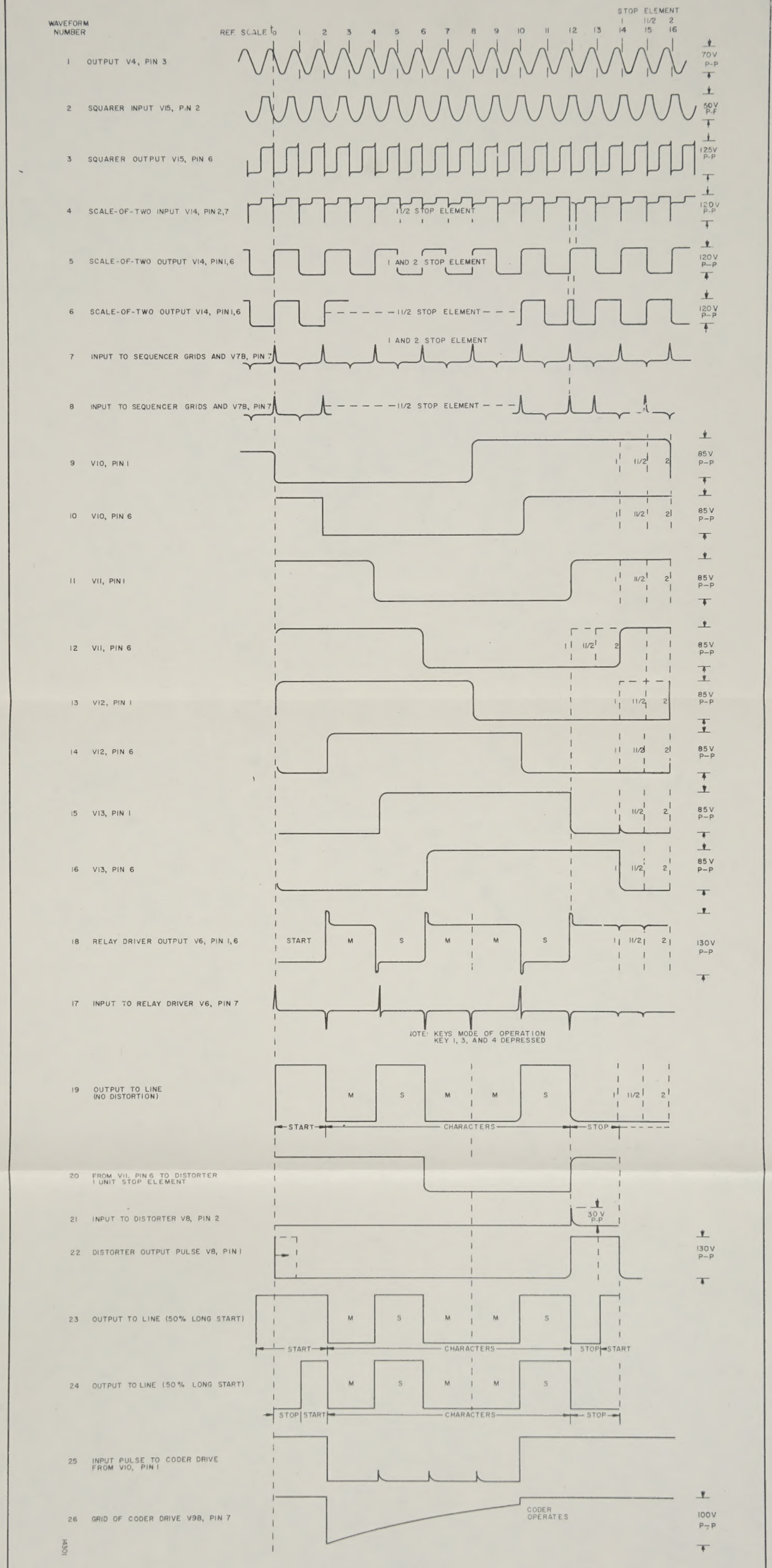


Figure 1-56. Transmitter Waveforms

chosen by the SIGNAL SELECTOR switch to provide 1:1 or 2:2 mark-space reversals, continuous mark or space signals, a predetermined message, or repetitions of any desired character. Continuous monitoring of the output is available since the CRT display is operated by the relay driver flip-flop under all conditions of transmission unless the DISPLAY switch is in the INPUT position.

Tubes V10B, V11A, V11B, V12A, and V12B in the ring counter provide outputs corresponding to the code elements of a character: These differentiated output pulses are controlled by a set of gates which select the desired code group. If a gate is open, a space is sent; if the gate is closed, a mark is sent. The four positions of the SIGNAL SELECTOR switch close the proper gates to give reversals or either type of continuous signals. In the KEYS position the gates are controlled by the front panel KEYS pushbuttons which set up the desired character for repeated transmission. In the CODER position an electro-mechanical coder controls the gates. To send the test message a disc in the coder operates a set of contacts controlling the gates in the correct order. Up to 100 characters can be transmitted and an external terminal permits a choice of sending a single message or repeated message.

When tube V13A in the counter conducts, a stop pulse is initiated and the counter can be set to continue this stop pulse length for one, one and one-half or two elements. A three-position STOP PULSE switch permits a choice of stop signals by changing the feedback connections to the ring counter or scale-of-two flip-flop. In the "1" position, feedback from V13A is applied to the ring so that V13B conducts immediately instead of one unit later. Thus, when the next pulse from the scale-of-two flip-flop arrives, V13B is already conducting and for that reason will not put out a pulse. In effect, the count is advanced by one additional stage when V13A conducts, actually changing the eight-count ring counter to a seven count. In the "1-1/2" position, feedback from V13A is applied to the scale-of-two flip-flop as a reset pulse to advance it one step. In the "2" position, no feedback is used and the seventh and eighth tubes in the counter operate normally to produce a two-unit stop signal.

(i) Relay Testing

Relays are tested using essentially the same arrangement as in Figure 1-54, except that the relay under test is substituted for the internal relay by connecting to the TDMS Transmitter through J102. The CRT displays the output of the test relay contacts. The distorter is not used and the ring counter is set to transmit continuous 1:1 reversals. For bias measurements, a negative voltage is applied to the contacts. Closing them produces a bright dot on the circular trace. When the two dots representing the two contacts are superimposed, the relay is properly adjusted for zero bias. Transit-time measurements are made by applying a positive voltage to the contacts; opening a contact produces a bright arc on the CRT. The time constant of the CRT-control tube is such that the arc is held until the next contact closure; the length of the arc indicates the transit time.

(j) Oscillator and Horizontal Drivers, V3, V4

This circuit is basically an R-C oscillator, comprised of tubes V3 and V4 (see Figure 1-57). The frequency is determined by the resistance-capacitance network which provides regenerative coupling between the output and input of the feedback amplifier. This feedback path is through a zero phase shift network which gives an output in phase with the input at one frequency only. The amplifier output is fed through a cathode follower to the R-C network before it is returned to the input.

Since the instrument requires a push-pull output to drive the horizontal deflector plates of the CRT, two such oscillators are combined. The frequency of this push-pull arrangement is controlled by varying the resistance while leaving the capacitances fixed. The RANGE switch selects the required resistance for the desired operating frequency range. The calibrated VERNIER potentiometers permit adjustment of the oscillator to the desired frequency. It should be noted that the sweep oscillator operates at twice the baud or modulation rate.

The cathode followers (V4A, V4B) couple the output of the oscillator circuits to the R-C network. They also tend to isolate the oscillator (V3) from any reaction to the following stages it triggers. Oscillator V3A and cathode follower V4B work in conjunction with one another; the same applies to V3B and V4A. R322 through R335 are calibration adjustment potentiometers for the particular frequency range in which they function.

Variable resistors R128 (COARSE AMP) and R129 (AMPLITUDE) are connected between the cathodes of V3 and control the gain of the circuit and hence the amplitude of the sweep oscillator. The COARSE AMP and AMPLITUDE resistors also control the amplitude of the horizontal scan voltages to the Y-axis plates, the amplitude of the oscillation fed to the vertical driver (V5), and the over-driven amplifier circuits (V15). Provision is made for synchronizing the sweep oscillator to an external signal by a sync injection circuit comprised of resistors R162, R163 and capacitor C111.

(k) Vertical Driver, V5, and CRT circuit, V17

The vertical driver, V5, is basically a push-pull amplifier. Signals fed to the grids are taken from the sweep oscillator frequency-controlling networks. Consequently, the signals at the plates, which drive the vertical deflection plates of the CRT, are also in quadrature phase with the voltage on the horizontal deflection plates; this results in a circular trace.

The VERT AMP potentiometer, R165, controls the gain (amplitude) of the stage. The circular trace is positioned on the Y-axis by the VERT POS resistor, R171.

The intensity of the trace is modulated by the input signal from the display amplifier, V1B, to the control grid (Figure 1-58). Control grid and cathode voltages for the CRT are obtained from the voltage divider, resistors R286 and R290. The beam intensity is adjusted by varying the INTENSITY control (R290). This control makes the control grid potential more or less negative with respect to the cathode, which is held at a fixed negative potential (less negative than the control grid). The FOCUS control (R288) varies the potential on the first anode (pin 4) and the ASTIG potentiometer (R285) controls the potential on the second anode (pin 8).

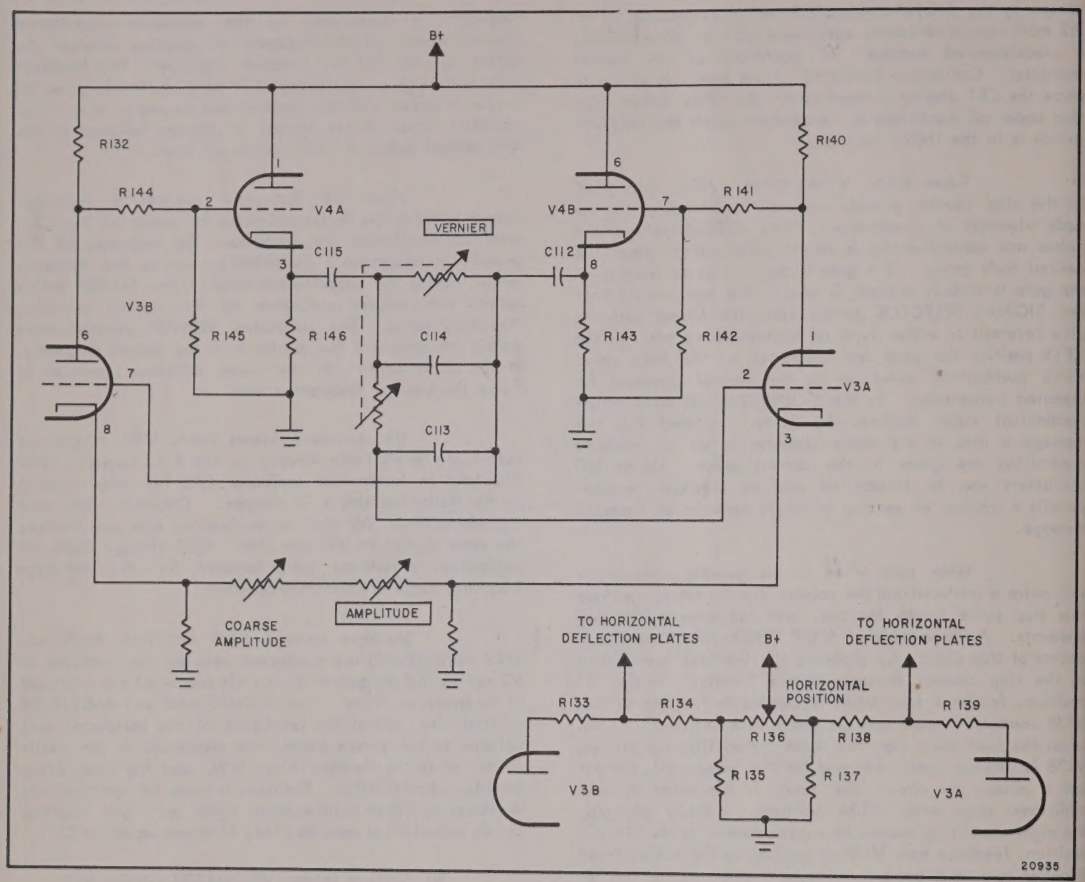


Figure 1-57. Oscillator and Horizontal Driver - Simplified Schematic Diagram

(l) Squarer Circuit, V15, and Speed Indicator Amplifier, V9

The sine-wave input signal from the cathode follower V4A is fed through coupling capacitor C154 to the grid of the squarer circuit V15. The squarer stage is an overdriven amplifier which is designed to distort the input signal waveform by a combination of cut-off limiting and saturation limiting. A common cathode resistor is used to improve the squaring action. The square wave output is fed to the scale-of-two flip-flop, V14, and the speed indicator amplifier V9A.

The speed indicator circuit provides a quick and accurate method of checking the sweep oscillator frequency. The square wave output from V15 is differentiated and applied to the grid of indicator amplifier V9A.

The input R-C network consists of resistor R219, capacitor C156 and, depending upon the position of the RANGE switch, capacitor C155, C171 or C172. Due to the positive bias on the grid, V9A is conducting heavily; hence the positive portion of the differentiated waveform is suppressed. The negative portion drives V9A beyond cut-off and its plate voltage rises. When the rising plate voltage reaches the firing point of the SPEED neon lamp, I-2, it fires. Then the tube returns to its conducting stage and the common anode voltage drops below the extinguishing potential of the SPEED neon.

(m) Scale-of-Two Flip-Flop, V14

The scale-of-two flip-flop, V14, serves as the triggering device for the ring counter and mark - control amplifier, V7B. Rectangular waveforms from squarer stage V15 are differentiated by capacitors C150 and C152 to give narrow pulses. Gate diode CR127 allows only the negative-going pulses to pass to the control grids of tube V14.

The output signal at the plate circuit of V14A is a rectangular waveform at half the frequency of the oscillator (V3, V4). Capacitor C148 differentiates the output signal and couples the positive-going pulses to the ring counter and mark-control amplifier. The negative-going portion is shorted to ground by diode CR126.

Additional cathode bias is applied to flip-flop V14 by resistor R268 in series with the normal operating bias.

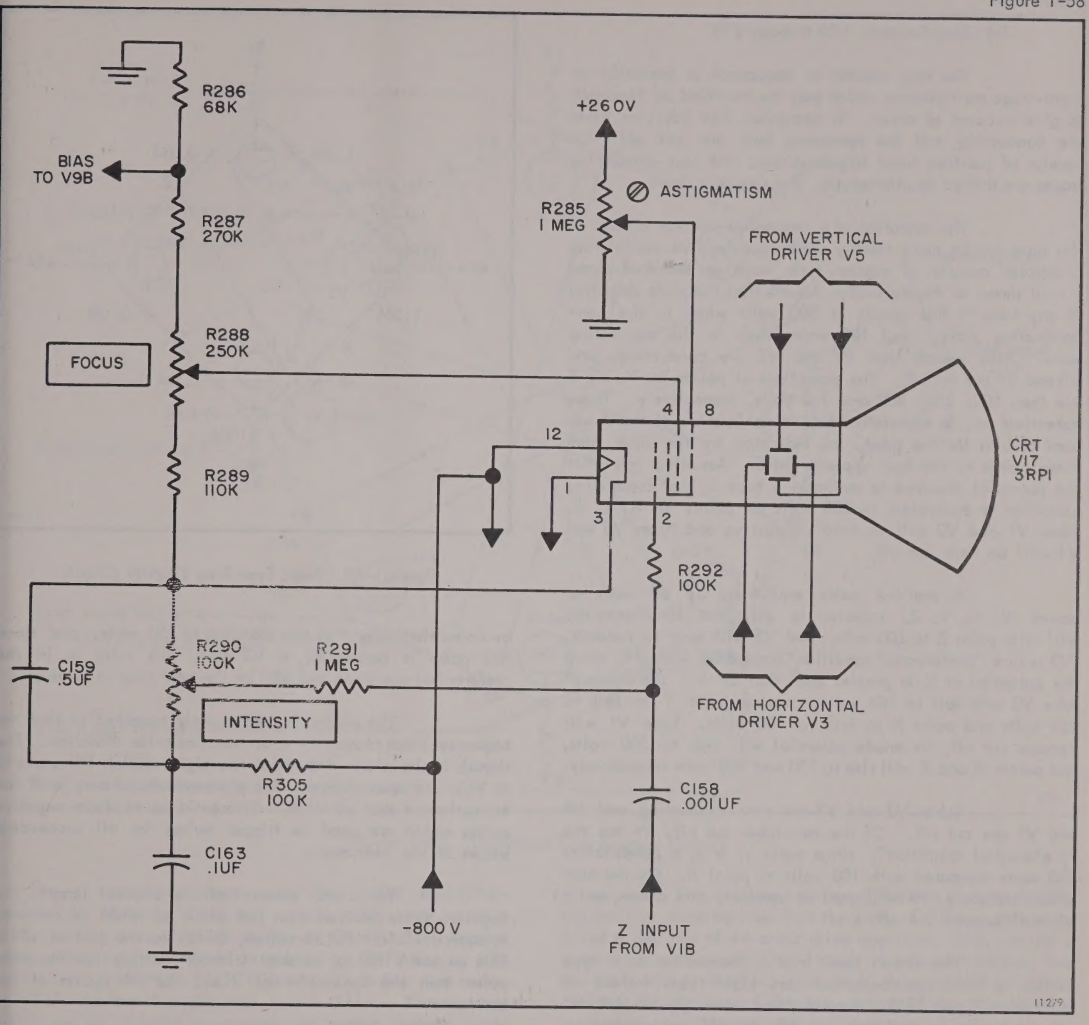


Figure 1-58. Cathode-Ray Tube Circuit - Simplified Schematic Diagram

his bias prevents V14 from operating and consequently the ounter stops functioning.

NOTE

1. For normal continuous operation R268 is shorted by placing an external switch (customer furnished) between pin 9 of the terminal strip (mounted on the power supply) and ground. This allows remote operation of the coder, so that a single message may be transmitted. Closing the remote switch and, as soon as the coder operates, opening it initiates the action. A pair of changeover contacts in the coder shorts out R268. Flip-flop V14 and the counter then operate normally and transmit the message to the line. At the end of the message the changeover contacts open, placing R268 in series with V14 cathode bias circuits and consequently stopping the transmitter.

2. Pin 9 of the associated power supply barrier strip must be grounded for all transmitting modes except the preceding example.

During CODER and KEYS operation a feedback signal from the counter triggers section V14B, placing this section in the conducting state. This feedback (reset pulse) is applied only when the STOP PULSE switch, S112, is in the "1-1/2" position. With V14B conducting, an input oscillator trigger pulse is required to change the state of V14, producing an output pulse which triggers the counter. This advances the start (space) pulse, the beginning of the new character.

(n) Ring Counter, V10 through V13

The ring counter or sequencer is basically an eight-stage multivibrator which may be modified by feedback to give a count of seven. In operation, four adjacent tubes are conducting and the remaining four are cut off. On receipt of positive input trigger pulses, the four conducting stages are shifted simultaneously, one step at a time.

The operation of a sequential counter circuit of this type may be more readily understood by first considering a simpler counter of similar type, such as the four-phase circuit shown in Figure 1-59. Assume that the plate potential of any tube in this circuit is 300 volts when in the non-conducting state, and 100 volts when in the conducting state. Also assume that V1 and V2 are conducting, and V3 and V4 are cut off. The potentials at points W, X, Y, Z are then 100, 250, 300 and 150 volts, respectively. These potentials (or, in a practical circuit, a fraction of them) are used as bias for the tubes, as indicated by the lines from these points to the four opposite grids. Assuming now that the potential required to maintain a tube in the conducting condition is equivalent to 200 volts at points W, X, Y, Z, tubes V1 and V2 will be held conductive and tubes V3 and V4 will be held cut off.

A positive pulse equivalent to 50 volts at points W, X, Y, Z, injected to all grids simultaneously will raise point Z to 200 volts, and V3 will start to conduct. (V3 is in a "preferential condition" compared with V4, since the potential at Z is greater than that at W.) The anode of tube V3 will fall to 100 volts, causing point Y to fall to 250 volts and point X to fall to 100 volts. Tube V1 will become cut off, its anode potential will rise to 300 volts, and points W and Z will rise to 150 and 300 volts respectively.

Tubes V2 and V3 are now conducting and V4 and V1 are cut off. Of the two tubes cut off, V4 has the "preferential condition", since point W is at a potential of 150 volts compared with 100 volts at point X. On the next pulse, therefore, V4 will start to conduct, and consequently V2 will become cut off.

The circuit used in the Transmitter is a type similar to that described, but uses eight tubes instead of four. (See Figure 1-60.) Assuming that tubes V2, V3, V4, V5 are not conducting and that V6, V7, V8, V1 are conducting, a state corresponding to the end of the start element exists, as set out in Figure 1-56 (V10-V13 anodes Ref. Scale "0").

Following the same general principles as for the four-stage sequencer, the potentials at the points Q, R, S, T, W, X, Y, Z are: Q, 250 volts; R, 300 volts; S, 300 volts; T, 300 volts; W, 150 volts; X, 100 volts; Y, 100 volts; Z, 100 volts.

If, as explained in the previous example, a 50-volt pulse is applied to all the grids, then the point W will be raised to 200 volts and tube V2 will conduct, since V2 was in a preferential condition. Then V2 plate voltage will fall to 100 volts, causing point Q to fall to 100 volts, and point R to fall to 250 volts. Similarly, the other points will be as follows: S, 300 volts; T, 300 volts; W, 300 volts; X, 150 volts; Y, 100 volts; Z, 100 volts; so that tubes V7, V8, V1, V2 are now conducting and V3, V4, V5 and V6 are not conducting. In other words the distributor has stepped around one position in a counterclockwise direction. It should

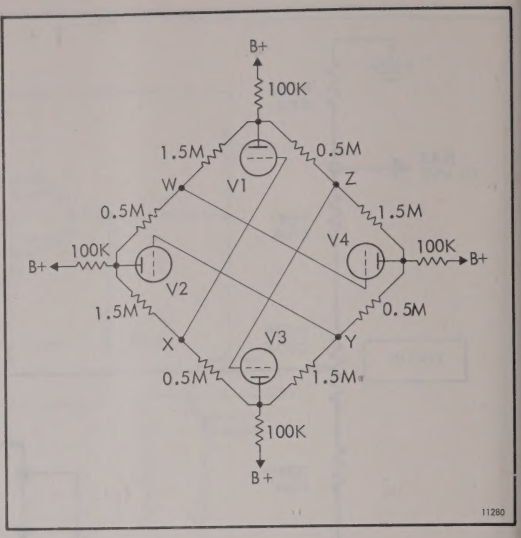


Figure 1-59. Basic Type Ring Counter Circuit

be noted that point X is now standing at 150 volts, and since this point is connected to V3 grid, this tube is in the preferential condition and will be the next tube to conduct.

The process is continuously repeated so that the sequencer steps around in a counterclockwise direction. The signals in the plate circuits of the eight section halves, V10 to V13, are square waves. The plate waveforms are, with the exception of that of V13B, differentiated to form negative pulses which are used as trigger pulses for all succeeding stages of the instrument.

For a stop element of one element length, the negative pulse derived from the plate of V13A is returned through the STOP PULSE switch, S112, to the grid of V11B. This causes V13B to conduct without waiting for the next pulse from the scale-of-two, i.e., for 14 cycles of the oscillator.

For a stop element of one and one-half units length, the negative pulse from the anode of V13A is fed back to the grid of V14B (scale-of-two flip-flop) causing it to conduct and V14A to cut off. The next pulse from the squarer (V15A) causes the scale-of-two to give a pulse to the ring counter which completes a full cycle for 15 cycles of the oscillator.

For the two-element stop pulse the ring counter performs a complete cycle for 16 cycles of the oscillator. (This is the normal condition of the counter.)

(o) Gate Circuit, Coder and Keys

The five negative-going pulses from the plates of V10B, V11A, V11B, V12A and V12B, Figure 1-55, pass through gate circuits. These circuits permit the five pulse sources of common pulse polarity to be connected to a common input. Since the five gate circuits are identical, only the number one gate circuit will be discussed.

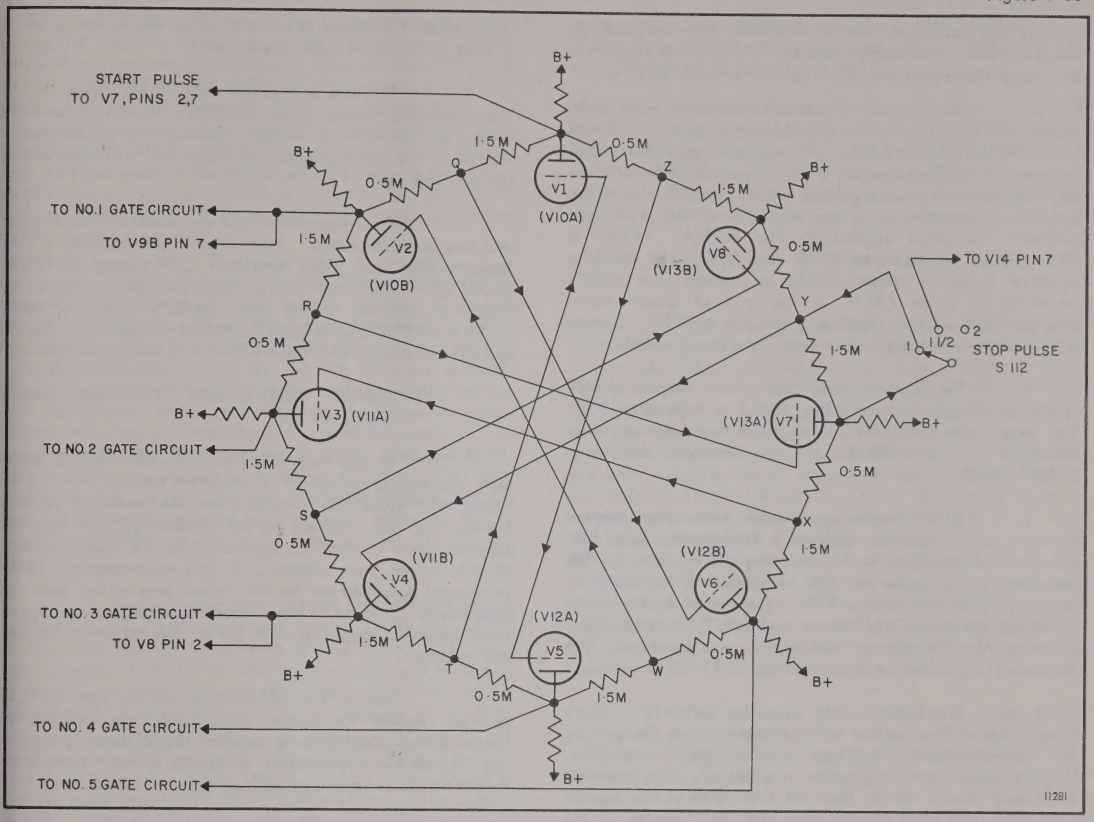


Figure 1-60. Simplified Ring Counter Circuit

Negative input pulses from V10B are differentiated by capacitor C143 and resistor R262; the positive going portion is suppressed by diode CR116. The negative going pulses may be shorted to ground at this point by the action of the SIGNAL SELECTOR switch, S104, the coder, or KEYS number 1 pushbutton switch S115. Those pulses which are not shorted to ground are passed through diode CR117 to the grid of the space - control amplifier, V7A. Diodes CR116 and CR117 prevent a ground introduced in this gate circuit from affecting the output of the other gate circuits. Without CR117 a ground introduced to this gate would effectively be applied to all. When the SIGNAL SELECTOR switch, S104, is in either the MARK or SPACE positions, the gate circuits are not used.

The message coder supplied with this instrument provides facilities for transmitting a telegraph test message of 100 characters. With the SIGNAL SELECTOR switch in the CODER position, ground connections for the gate circuits are controlled by the pattern printed on the coder disc. Each gate is connected to a contact arm so that when the arm is on a conducting portion of the pattern (which is grounded) the gate is closed. When the arm is on an insulated portion of the disc the gate is open and the pulses are fed to the space control amplifier, V7A. Upon completion of a character the disc steps clockwise slightly (3.6°), bringing into position a new pattern for transmission of the next character.

The rotational timing of the disc is controlled by the positive pulse derived from the plate of V10B. This pulse is fed to the grid of the coder drive amplifier, V9B, which is normally biased to cutoff by a negative potential derived from the CRT voltage divider. The input pulse to V9B is differentiated by capacitor C134 and resistor R216. The negative portion of the differentiated waveform has no effect on the negative-biased grid; the positive portion drives the stage into a hard current condition, operating the electromagnet which rotates the coder disc one step by means of a ratchet and pawl mechanism. The coder drive amplifier is prevented from operating in positions other than CODER by cathode-bias resistor R218 inserted into its cathode circuit by the SIGNAL SELECTOR switch. Refer to paragraph 5c(1)(d) for the mechanical configuration of the coder.

With the SIGNAL SELECTOR switch in the KEYS position, the gates may be manually set for any desired character, which is then repeatedly sent by the instrument.

(p) Mark Control and Space Control Amplifiers, V7B and V7A

The mark control amplifier is normally biased at cutoff by the application of a high positive voltage through resistor R192 to its cathode. The first element of a character is a start-space pulse. To obtain this pulse, the positive

mark-setting pulse from the scale-of-two flip-flop must be cancelled and space-control amplifier V7A must be triggered; this places the relay driver flip-flop in the space condition.

The ring counter generates a square wave pulse at the plate of V10A which is applied to the gate of V7B and to the DISPLAY switch S105. This start pulse is differentiated by capacitor C123 and resistor R194. Diode CR109 shorts the positive portion to ground. In this manner, cancellation of the positive mark-setting pulse from the scale-of-two is accomplished. The pulse applied to the DISPLAY switch is differentiated by capacitor C128 and R203; the resulting negative pulse is passed through a series gate circuit consisting of diode CR114 to the grid of space control amplifier V7A. This negative pulse cuts off V7A, causing it to place the relay driver flip-flop in the space condition.

The negative pulse applied to the grid of V7B is also fed through resistor R306 to pin 3 of receptacle P101. This negative output pulse is timed with the stop-start pulse transition and is available at the terminals designated SCOPE SYNC.

At the beginning of each succeeding element the mark control amplifier receives a mark-setting pulse from the scale-of-two flip-flop which causes V7B to conduct. The negative - going pulse at the plate is differentiated by capacitor C124 and resistor R198. The sharp negative pulse passes through diode CR110 to the grid (pin 7) of relay driver flip-flop V6, thus placing V6 in the mark condition. The positive-going pulses are suppressed by CR110.

The space control amplifier normally conducts heavily due to the positive voltage impressed on the grid by the resistor network consisting of R201, R202, and R204. When a negative - going pulse is received, via capacitor C128 and diode VR114, from the first plate of the counter or through the gate circuits from the later anodes of the counter, a large positive pulse is produced at the plate of V7A. This pulse is differentiated by capacitor C125 and resistor R196 and passed to the relay driver flip - flop. The negative portion of the differentiated waveform is suppressed by diode CR111. The positive pulse from the space control amplifier is roughly twice as large as the negative pulse from the mark control amplifier, so the positive pulse prevails.

(q) Relay Driver Flip-Flop, V6, and Output Relay and Control

The relay driver flip-flop is a bistable multivibrator circuit which changes states only when driven by an external pulse. For mark signal elements, a negative pulse is fed from the mark control amplifier to the grid of V6B, causing it to be cut off and thereby causing V6A to conduct. For space signal elements, a positive pulse is fed from the space control amplifier to the grid of V6B, causing it to conduct. When the INPUT SIGNAL switch is set to SPACE, a ground potential is applied to the grid of V6A. This has the effect of holding V6A in a cut-off condition despite incoming pulses from the mark- and space-control amplifiers; output relay RL3 is thus held continuously in a space condition. When the SIGNAL SELECTOR switch is in the MARK position, negative-going pulses from V7B cut off V6B, and the output relay is held continuously in a mark condition.

When the DISPLAY switch is set to NORMAL, DISTORT, or INPUT, V6 drives internal output relay RL3. In the BIAS and TRANSIT TIME positions the output from the relay driver flip-flop is fed to the relay test socket where it is used to drive the relay under test.

The internal output relay (RL3) used in the Transmitter is a Western Union type 202A. This relay functions during all transmitting modes. Testing and adjustment of the relay are accomplished by using the instrument's own testing facilities.

The relay control unit comprises an output filter and two barretter lamps. The output filter consists of the resistors R187 and R188, capacitors C118 through C122 and chokes L101, L102, and L103. Its purpose is to suppress the effects of sparking at the relay contacts. Barretter lamps RT189 and RT190 are included in the space and mark circuits to limit the current which would flow in a fault condition.

(r) Distorter Multivibrator, V8, and Display Amplifier, V1B

In order to produce a signal with long or short-start element distortion, it is necessary to (1) remove the normal start-pulse, (2) provide a new start-pulse of variable timing, and (3) suppress the mark-resetting pulse from the scale-of-two flip-flop corresponding to the commencement of the normal start element. If this mark-resetting pulse, previously cancelled out by the normal start-pulse, were not suppressed, it would, when long-start distortion was in use, reset the output toggle to mark during the period of the new start-element.

Setting the DISPLAY switch to the DISTORT position removes the normal start pulse and cancels the corresponding positive pulse whether the distorter is used or not. Since the stop element is always a mark signal, the output flip-flop remains at mark until a start arrives.

Distorter V8 is a delay - type monostable multivibrator circuit. Section V8A is cut off and V8B conducts, due to the positive bias on its control grid. When a positive pulse from the plate of V11B is applied to the grid of V8A the section conducts, applying negative bias to the grid of V8B causing it to be cut-off. After a time delay, which is determined by the amount of capacitance selected by the RANGE switch and adjustment of the DISTORTION control, R213, the circuit returns to its original condition. When V8B again conducts, a negative pulse is fed to the grid of the space control amplifier, V7A, to initiate the start element.

The display amplifier is normally conducting heavily due to the positive bias impressed on its grid by resistor R123. Signals selected by the DISPLAY switch, S105, are amplified by V1B and passed to the grid of the CRT by coupling circuits.

(s) Relay Test Circuit

Connector J102 on the front panel accommodates Western Union Relay Model 202A. The relay under test is plugged into this connector; its mark and space contacts connected to terminals M and S, and its armature connected to terminal T (M, S and T are included in J102). The coil (terminals O, A, J102) of the relay is driven by signals from the relay driver flip-flop, V6. Model 14-101 Relay Test Adapter may also be plugged into J102 for testing Western Electric Model 255A and Sigma Model 72, and Western Union Model 203 relays.

In the BIAS position the DISPLAY switch applies a negative potential derived from the CRT potential divider networks to the contacts of the relay via capacitors C116 and C117. (Diodes CR106 and CR107 do not conduct during bias testing and may be ignored.) When the tongue is in the alternating position, capacitors C116 and C117 discharge through resistors R185 and R186. As the tongue makes contact with the fixed contacts the tongue potential falls to that of the fixed contacts. As the appropriate capacitor (C116 or C117) charges through resistor R122 the tongue potential rapidly rises to near ground potential.

The sharp negative pulses developed are fed to the grid of the display amplifier through capacitor C108 and the DISPLAY switch. Since the sweep frequency is twice the baud rate, two bright dots on the CRT will be seen if the relay tongue transit times and the rest times are unequal. The dots represent the mark and space contacts making contact with the tongue. If the time taken by the tongue to travel in both directions and rest times are equal the spots will be superimposed. The time constants of C116, R185 and C117, R186 are just long enough to discharge C116 and C117 only slightly during contact bounce; the pulse produced by the tongue again during bounce is very small compared to the original. Contact bounce is thus not conspicuous on this display.

In the Transit Time position the DISPLAY switch applies a positive voltage through diodes CR106 and CR107 to the mark and space contacts of the relay under test. (Capacitors C116 and C117 and resistors R185 and R186 may be disregarded since they are effectively short-circuited by the diodes.) A positive pulse is thus applied across R122 whenever the tongue contact is in contact with one of the fixed contacts (mark or space). This positive pulse is coupled through C108, which blocks the dc element of the signal so that the pulse goes both positive and negative at the display amplifier (V2B) grid. The negative portion of this pulse occurs during the transit time of the relay. (The length of this negative portion is a direct function of the relay's transit time.) During the time the tongue is in transit (transit time) from one contact to the other there is no voltage across R122. The negative pulse causes a bright arc to appear on the CRT screen. As in the bias test, the relay is driven at one-half sweep rate; arcs corresponding to the transit time are superimposed if the relay is bias free.

Relays may also be tested for contact bounce during transit time tests. Contact bounce appears on the CRT as a series of dots following the transit time arc. These dots are caused by the grid of V2B going negative again when the relay tongue bounces off a contact instead of holding. Each time the tongue bounces the flow of positive voltage across R122 is interrupted, the grid of V2B goes negative, and a spot appears on the CRT. Each time the tongue bounces another spot appears on the trace.

(t) Input Circuits

The input terminals marked INPUT 1 and INPUT 2 are used in conjunction with the INPUT COMMON GRD terminal and carry the incoming signals to be monitored. The input impedance for INPUT 1 terminal, (high 220K ohms or low 270 ohms) is controlled by the INPUT IMP switch, S111. This terminal (INPUT 1) is used for evaluating high level signals from 25 to 200 volts. Signals appearing between INPUT 1 and INPUT COMMON pass through an attenuator if the high or low impedance switch is in the HIGH position. INPUT 2 has a high sensitivity input, (220K ohms), for use on input signals as low as 2.5 volts.

The output from the attenuator is fed to one grid (V16A) of the isolation amplifier, V16. The INPUT COMMON terminal is connected to the other grid. The output of the isolation amplifier is connected, through S103, or the neutral-to-polar converter, to the grid of the input amplifier, V1A. The S103 switch is set to the type of signal being observed.

(u) Floating or Isolation Amplifier, V16, and Neutral-to-Polar Converter

This stage is a cathode coupled amplifier with differential (balanced) input and single ended (ground referenced) output of about unity gain. Balanced input signals are fed through grid limiting resistors R293 and R296 to the grids of V16, which amplifies the potential difference between the two grids and attenuates signals common to both grids (such as ac ripple). The amplified output is taken from pin 6 and coupled through voltage divider R298 and R300 to the SIGNAL SELECTOR switch, S103. The output signal is in phase with the input signal connected to pin 2 of V16. This allows the INPUT COMMON terminal to be grounded for use with unbalanced lines. The resistive voltage divider network, R298, R300, and R30, dc couples the signal from the plate of V16, which is at a positive potential, to the SIGNAL SELECTOR switch at zero dc potential. The INPUT BAL control, R301, adjusts the "no signal" voltage at the junction of R298 and R300 to zero potential.

The input to V1A must be a polar signal (balanced about ground). The following discussion is for positive mark signals. For negative mark signals the connections to the diode are reversed by the INPUT SIGNAL switch.

Assuming the circuit has a steady mark applied to it, diode CR101 conducts and capacitor C101 charges to the full mark voltage. Half of the voltage appears at the junction of resistors R106 and R107. When a space signal arrives, the input drops to ground potential and the diode is cut off. Capacitor C101 then discharges through R106 and R107; the potential at the junction of these resistors drops to a level equal to half the steady mark below ground. This results in a polar output which is applied to the input amplifier, V1A.

(v) Input Amplifier, V1A, and Double Inverter, V2

The double inverter is a bistable multivibrator which is triggered by input amplifier V1A. The input amplifier has a very small grid bias which enables the stage to fully conduct or to be completely cut off by input signals with small values. Amplifier V1A is directly coupled to the multivibrator, thus serving as the grid leak for V2A.

A positive input signal to V1A causes V2A to be cut off and V2B to conduct. Negative inputs cause the reverse condition. Since only a small potential is required to completely cut off V1A, the input signal to this circuit must be balanced about ground.

The waveforms at the plates of V2 are rectangular. The output pulses are differentiated and the negative portion is passed to the grid of display amplifier

V1B when the DISPLAY switch is in the INPUT position. The positive pulses are shorted to ground by diodes CR102 and CR103. Each changeover of the input signal is thus displayed as a bright dot on the CRT trace.

(w) Power Control Circuits

Power switch S101, mounted on the INTENSITY control, controls the application of primary power to the associated power supply. When the switch is closed 6.3 volts ac is applied to power control relay RL2, which controls all the input supply voltages except the -150 volt input. The first pair of closed contacts of RL2 applies 6.3 volts ac to the POWER indicator lamp, all tube filaments (except CRT), and thermal delay relay RL1. The 30-second delay relay is included in order to prevent application of plate potential before the tube heaters have warmed up. The second and third sets of contacts apply 6.3 volts ac to the CRT filament. One side of the CRT filament voltage is referenced to -800 volts. The last set of contacts applies 450 volts to the coder amplifier plate through the coder winding.

(x) Troubles and Probable Solutions

The troubles and the probable solutions listed in Table XI are representative in nature. Figures 2-1 through 2-23 of Section II will prove helpful in locating components.

TABLE XI. TRANSMITTER TROUBLES AND PROBABLE SOLUTIONS

TROUBLE	SOLUTION
POWER indicator lamp does not light and no trace on CRT screen.	Check line fuse in associated power supply. If this fuse is blown check the power supply and Transmitter for the cause before replacing. Check for shorts in the Transmitter filament circuit and ac power switch circuit. If the line fuse is not blown check on - off switch and power control relay RL2.
POWER indicator lamp and SPEED indicator lamp light but no trace visible on the CRT.	Check the negative high voltage fuse in the power supply. Refer to the associated power supply portion of this manual for possible causes of failure of -800 volt circuit. Check RL2 for faulty contacts. Check CRT.
POWER indicator lights but SPEED indicator does not light and CRT has a bright dot in center of screen.	Measure the +260 vdc at pin 9 of RL1. If no voltage is present at this point see the associated power supply manual for possible cause of failure of +260 volt circuit. If +260 vdc is present at pin 9 of RL1, measure the voltage at pin 3 of RL1. If +260 volts is not present at this point, replace RL1. If +260 volts are present at RL1 pin 3, check R303 for open. If open check the various B+ points in the Transmitter for a short. Check C161 for short.

TABLE XI. TRANSMITTER TROUBLES AND PROBABLE SOLUTIONS (Continued)

TROUBLE	SOLUTION
	If +260 volt circuit proves correct, check tubes V3 and V4; if tubes are good check associated components in the oscillator circuit.
POWER indicator lights, SPEED indicator does not light, and CRT presentation normal on circular time base, except that no bright dots are present on the trace, and the Transmitter does not transmit.	Check tube V15. If this tube is good check components in squarer circuits. Use the tables of resistances and voltages to localize the faulty component. If an oscilloscope is available, the waveforms shown on Figure 1-56 can also be used to locate the trouble.
POWER indicator lights and SPEED indicator lights but CRT has only a horizontal line.	Check V5 and setting of VERT AMP control R165; check components in vertical amplifier circuit.
POWER indicator lights, SPEED indicator lights, no dots are present on the trace, but the Transmitter functions normally.	Check V1B. If this tube is good, check the components in the display amplifier. Use the resistance and voltage tables to localize the trouble. If an oscilloscope is available the waveforms shown in Figure 1-56 can be used to help localize the trouble.
Transmitter functions normally when transmitting, but does not function in the receiving mode.	Check V1, V2, and V16, and their associated components. Check for -150 volts from the power supply. If -150 volts are not present, refer to the appropriate power supply manual to determine probable cause.
CRT display normal but there are no bright dots on the trace and the Transmitter does not function regardless of the positioning of the SIGNAL SELECTOR switch; the SPEED indicator is lit.	Check V6 and RL3. If these components prove to be operational check the associated components around V6.
Normal circular time base on the CRT; SPEED indicator is lit; Transmitter operates only in the MARK and SPACE positions of the SIGNAL SELECTOR switch.	Check pin 9 of the barrier strip on the power supply to determine if this pin is firmly attached to ground. If it is, check V14, and V10, V11, V12, V13, and V7. If these tubes prove to be good, check the associated components and use the resistance and voltage tables and the waveforms to localize the trouble. (See Tables XII and XIII.)

TABLE XII. TRANSMITTER RESISTANCE CHART

REF. SYMBOL	TUBE TYPE	PIN 1	PIN 2	PIN 3	PIN 4	PIN 5	PIN 6	PIN 7	PIN 8	PIN 9	PIN 10	PIN 11	PIN 12
V1	12AU7	1M	1.5M	22K	0.15	0.15	150K	1.25M	0	0			
V2	12AU7	130K	2M	33K	0.15	0.15	150K	1.25M	33K	0			
V3	12AX7	210K	4M	34K	0.15	0.15	250K	4M	34K	0			
V4	12AU7	40K	500K	110K	0.15	0.15	40K	450K	110K	0			
V5	12AX7	220K	4M	30K	0.15	0.15	220K	4M	30K	0			
V6	12AU7	65K	270K	6.5K	0.15	0.15	65K	250K	6.8K	0			
V7	12AU7	150K	650K	0	0.15	0.15	170K	480K	27K	0			
V8	12AU7	150K	1.7M	27K	0.15	0.15	150K	350K to 2M	27K	0			
V9	5687	80K	1.1M	0	0.15	0.15	220K	1.5M	0	∞			
V10	12AU7	120K	1.2M	17K	0.15	0.15	120K	1.2M	17K	0			
V11	12AU7	120K	1.2M	17K	0.15	0.15	120K	1.4M	17K	0			
V12	12AU7	120K	1.2M	17K	0.15	0.15	120K	1.2M	17K	0			
V13	12AU7	120K	1.2M	17K	0.15	0.15	120K	1.2M	17K	0			
V14	12AU7	125K	220K	25K*	0.15	0.15	125K	220K	25K*				
V15	12AU7	135K	2M	40K	0.15	0.15	135K	440K	40K	0			
V16	12AU7	40K	1.5M	110K	0.15	0.15	150K	1.5M	130K	0			
V17	3RP1	900K	2M	700K	330 to 500K	∞	650K	650K	0 to 280K	1.1M	1.1M	∞	900K
RL1	6N030T	0.15	150K	40K	40K	160K	0	90K	1M	1M			

NOTES: Transmitter set for KEYS normal output, at 50 bauds, S111 in low impedance, and 1-1/2 stop pulse length.

* Pin 8 of P101 Grounded

All R measurements taken with a 20,000 ohms per volt multimeter.

(y) Cathode Ray Tube Removal and Installation

WARNING

VOLTAGES DANGEROUS TO LIFE ARE PRESENT. DISCONNECT POWER WHEN HANDLING THE SOCKET.

Step 1 To remove the CRT place the Transmitter on the bench.

Step 2 Remove output relay from its socket.

Step 3 Remove the socket assembly from the base of the tube.

Step 4 Unfasten the clamp at the rear of the tube shield.

Step 5 Remove the screw supporting the CRT shield at top front of unit.

Step 6 Lift the tube rearwards from the panel.

Step 7 Remove shield from the tube.

CAUTION

Do not bump or bend the CRT shield as it may affect its magnetic properties.

Step 8 To replace the CRT insert the tube into the shield.

Step 9 Position the face of the tube against the cushion.

TABLE XIII. TRANSMITTER VOLTAGE CHART

REF. SYMBOL	TUBE TYPE	PIN 1	PIN 2	PIN 3	PIN 4	PIN 5	PIN 6	PIN 7	PIN 8	PIN 9	PIN 10	PIN 11	PIN 12
V1	12AU7	13 vdc	0	0.95 v	6.3 vac	6.3 vac	16 v	0.35 v	0	0			
V2	12AU7	60 to 165 v	2 to 7 v	40 v	6.3 vac	6.3 vac	60 to 165 v	2 to 7 v	40 v	0			
V3	12AX7	130 v	0	28 v	6.3 vac	6.3 vac	130 v	0	28 v	0			
V4	12AU7	240 v	90 v	115 v	6.3 vac	6.3 vac	240 v	90 v	115 v	0			
V5	12AX7	130 v	0	28 v	6.3 vac	6.3 vac	130 v	0	28 v	0			
V6	12AU7	150 v	21 v	32 v	6.3 vac	6.3 vac	90 v	33 v	28 v	0			
V7	12AU7	25 v	0	0	6.3 vac	6.3 vac	60 v	0.2 v	9 v	0			
V8	12AU7	165 v	15 v	40 v	6.3 vac	6.3 vac	45 v	38 to 48 v	40 v	0			
V9	5687	40 v	-4.5 v	0	6.3 vac	6.3 vac	0.5 v	-4 v	0	450 v			
V10	12AU7	115 v **	45 v	65 v	6.3 vac	6.3 vac	115 v **	45 v	65 v	0			
V11	12AU7	115 v **	45 v	65 v	6.3 vac	6.3 vac	125 v **	45 v	65 v	0			
V12	12AU7	120 v **	45 v	65 v	6.3 vac	6.3 vac	125 v **	45 v	65 v	0			
V13	12AU7	120 v **	45 v	65 v	6.3 vac	6.3 vac	120 v **	45 v	65 v	0			
V14	12AU7	105 v *	23 v *	33 v *	6.3 vac	6.3 vac	115 v *	20 v *	33 v *	0			
V15	12AU7	130 v	25 v	50 v	6.3 vac	6.3 vac	115 v	35 v	50 v	0			
V16	12AU7	190 v	0	10 v	6.3 vac	6.3 vac	80 v	0	3.6 v	0			
V17	3RP1	-800vdc	-580 v	-610 v	-275 to -475	0	115 v	115 v	0 to 240 v	100 v	100 v	0	-800vdc
RL1	6N030T	6.3 vac	47 v	260 v	260 v	45 v	0	135 v	260 v	260 v			

NOTES: Transmitter set for KEYS normal output, at 50 bauds, S111 in low impedance, and 1-1/2 stop pulse length.

All V measurements taken with a 20,000 ohms per volt multimeter.

* Pin 8 of P101 Grounded.

** Voltage varies between 110-125 v depending upon trigger position of ring counter.

v Indicates dc voltage to ground.

vac Indicates ac voltage to ground.

Step 10 Replace the screw supporting the front of the tube.

Step 11 Replace the socket assembly.

Step 12 Replace the output relay.

Step 13 Turn Transmitter on and rotate tube until the bright dot appears under zero on the CRT scale when the DISPLAY switch is in the NORMAL OUTPUT position.

Step 14 Fasten the clamp at the rear of the tube shield.

(z) Checkout Procedure

Step 1 Perform the adjustment procedure given in paragraph 4a (1).

Step 2 Ground CODER terminal pin 9 on power supply terminal board. (This shorts out R268 to ground and enables the scale-of-two (V14) to operate, which in turn allows the coder and output relay (RL3) to function.

Step 3 Synchronize the test scope with the Transmitter SCOPE SYNC output (terminal 1-2) on the power supply terminal board.

Step 4 Connect the vertical input of the test scope to pin 6 of V6 and ground.

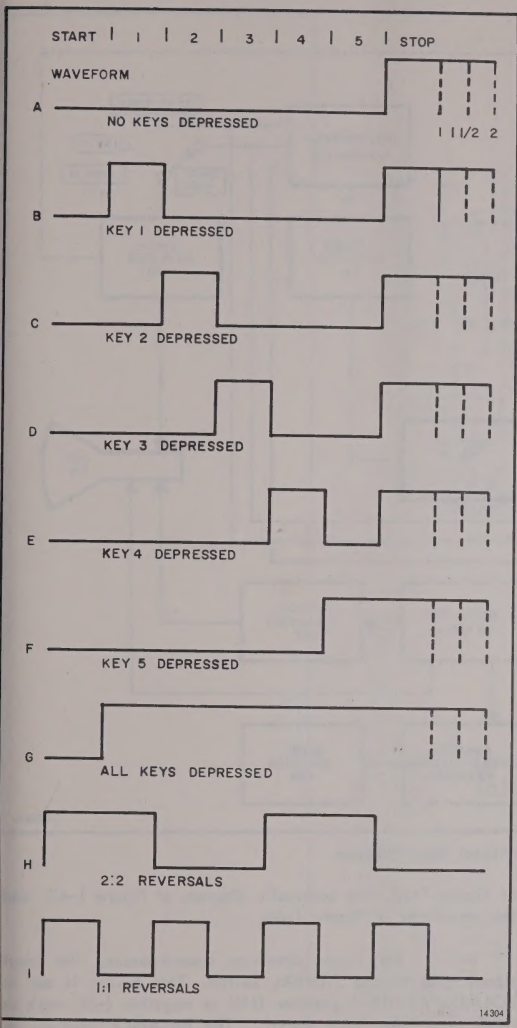


Figure 1-61. Operation Test Waveforms

Step 5 Set front panel controls as follows:

Switch	Position
SIGNAL SELECTOR	KEYS
DISPLAY	NORMAL OUTPUT
RANGE	50
VERNIER	0
STOP PULSE	1
KEYS	None depressed

Step 6 Observe waveform A, Figure 1-61, with none of the KEY pushbuttons depressed. As the KEY pushbuttons are depressed and released, one at a time, the waveforms should resemble waveforms B, C, D, E, F and G.

Step 7 Place the STOP PULSE switch in position "1-1/2" and repeat Step 6 above. The stop pulse should widen to one and one-half times its previous size.

Step 8 Place the STOP PULSE switch in position "2" and repeat Step 6. The stop pulse should double in width, as compared to the pulse when the STOP PULSE switch was in position 1.

Step 9 Repeat Steps 6, 7 and 8 with the DISPLAY switch in the DISTORT OUTPUT position. When the DISTORTION control is rotated from 50 percent short to 50 percent long distortion, as read off the calibrated graticule, the stop pulse should change in width proportionately.

Step 10 Set the SIGNAL SELECTOR switch to 2:2 reversal and the DISPLAY switch to NORMAL OUTPUT.

Step 11 Set the SIGNAL SELECTOR switch to 1:1 reversal and observe waveform I, Figure 1-61.

Step 12 Set the SIGNAL SELECTOR switch to SPACE and observe a constant space signal.

Step 13 Set the SIGNAL SELECTOR switch to MARK and observe a constant mark signal.

Step 14 Remove output relay from its socket and insert in front panel connector. Adjust Transmitter controls for 1:1 reversal, NORMAL OUTPUT at 50 bauds. Perform the bias test on output relay, Paragraph 4b(3)(d).

NOTE

In order to adjust relay for bias loosen the lock screws slightly. Using a feeler gauge, gap the open contact to 2 mils (0.002 inch). Two slightly displaced dots will appear on the circular trace. By turning one adjustment slightly and then the other by the same amount in the opposite direction, it is possible to superimpose the dots.

Step 15 Perform transit time test on the relay, Paragraph 4b(3)(e).

NOTE

In order to adjust relay contacts for transit time, adjust screws slightly in same direction. Adjustment is made until arc on trace covers three to four lines on the graticule calibration scale and contact bounce is eliminated.

Step 16 Repeat Steps 14 and 15 because any adjustment made during these steps interacts slightly.

Step 17 Perform Steps 4 through 8 in quick operation check, Paragraph 4a (1)(b).

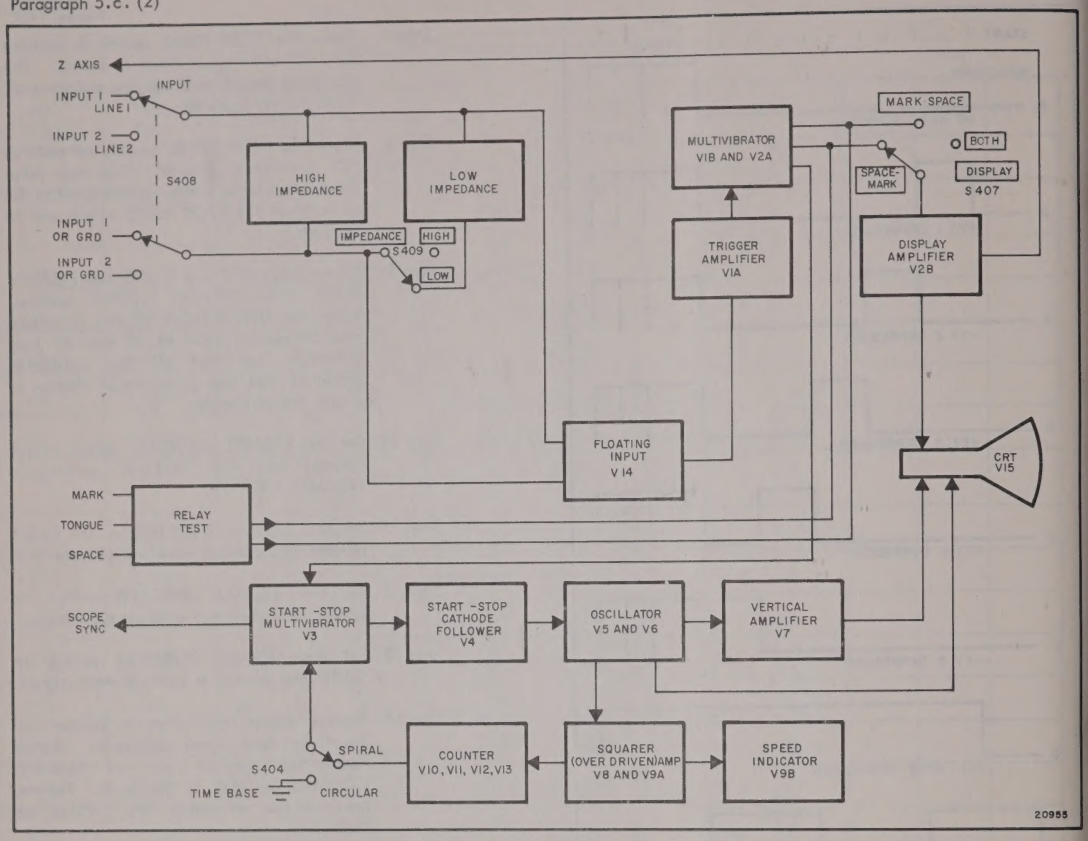


Figure 1-62. Receiver - Functional Block Diagram

(2) Receiver

(a) Figures and Tables

Figure 1-62. Receiver Functional Block Diagram
Figure 1-63. Receiver Schematic
Figure 1-64. Receiver Waveforms
Figures 2-24 through 2-43, Section II
Table XIV. Troubles and Probable Solutions
Table XV. Receiver Resistance Chart
Table XVI. Receiver Voltage Chart

(b) Tools and Equipment

Electronic Tool Kit
Tube Puller
Brush, stiff bristle (non-metallic)
Multimeter (20,000 ohms per volt)
Oscilloscope
Signal Generator (audio)
Electronic Counter (or other frequency measuring device)

(c) Receiver Functional Description

The discussions in Paragraphs 5c(2)(a) through 5c(2)(p) will be clarified by reference to the block diagram of Figure 1-62, the schematic diagram of Figure 1-63, and the waveforms of Figure 1-64.

For signal distortion measurements, the input signal goes to the SIGNAL switch. This switch is set to POLAR or NEUTRAL positive (+M) or negative (-M) mark as required by the input signal. The BALANCE control, in conjunction with an external oscilloscope, is set to give the desired sampling point on neutral or polar waveforms. With a synchronous input signal, the DISPLAY switch is set to show all transitions: the TIME BASE switch is set to CIRCULAR. A number of bright dots should appear on the circular trace. When the MODULATION RATE controls are properly adjusted the internal oscillator will be synchronized with the signal and the dots will be stationary. If the signal is undistorted, the dots will coincide. If distortion is present, one or more dots will be displaced and the distortion can be read from the scale.

To measure start-stop signals, the TIME BASE switch is set to the SPIRAL position; the UNIT CODE switch is set for the number of units in a character; the SIGNAL switch is set to POLAR or NEUTRAL, +M or -M, as required. Since the spiral display is triggered by the start space, the stop signal does not have to be an even multiple of the unit or half-unit. A perfect incoming signal will be displayed as

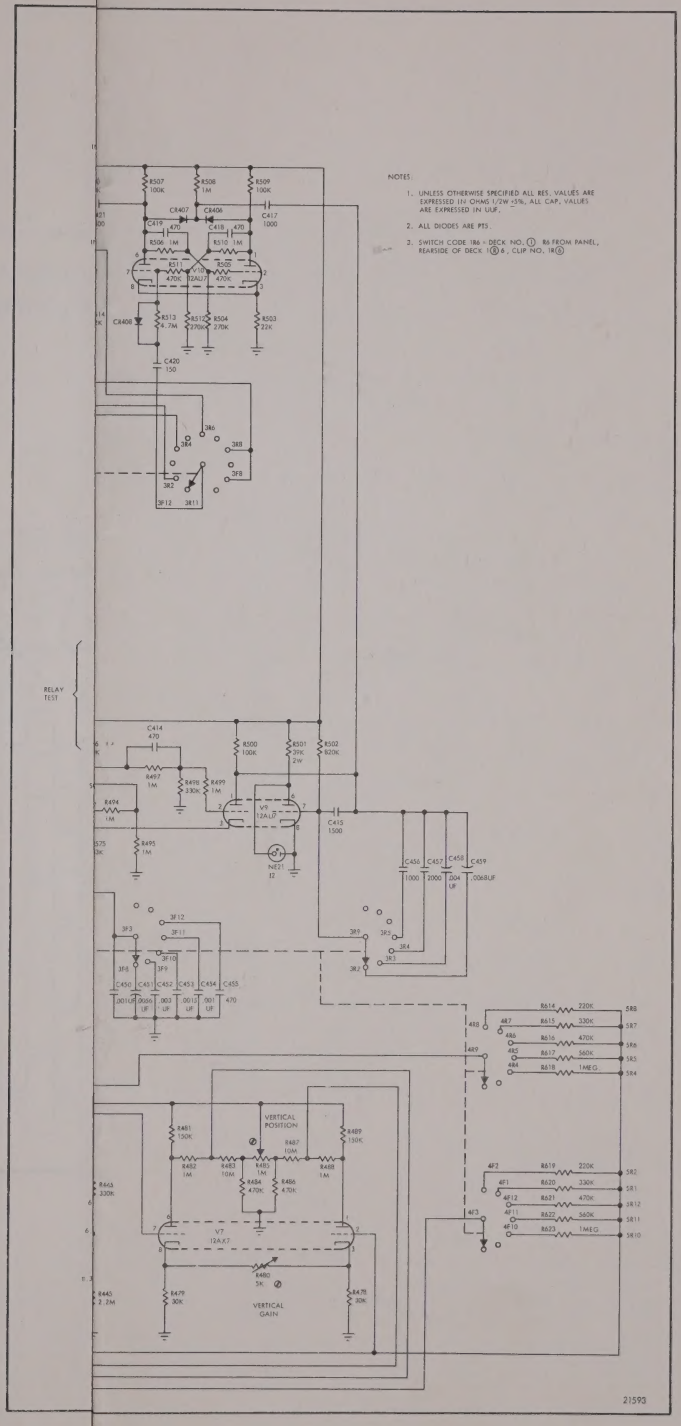


Figure 1-63. Receiver Schematic

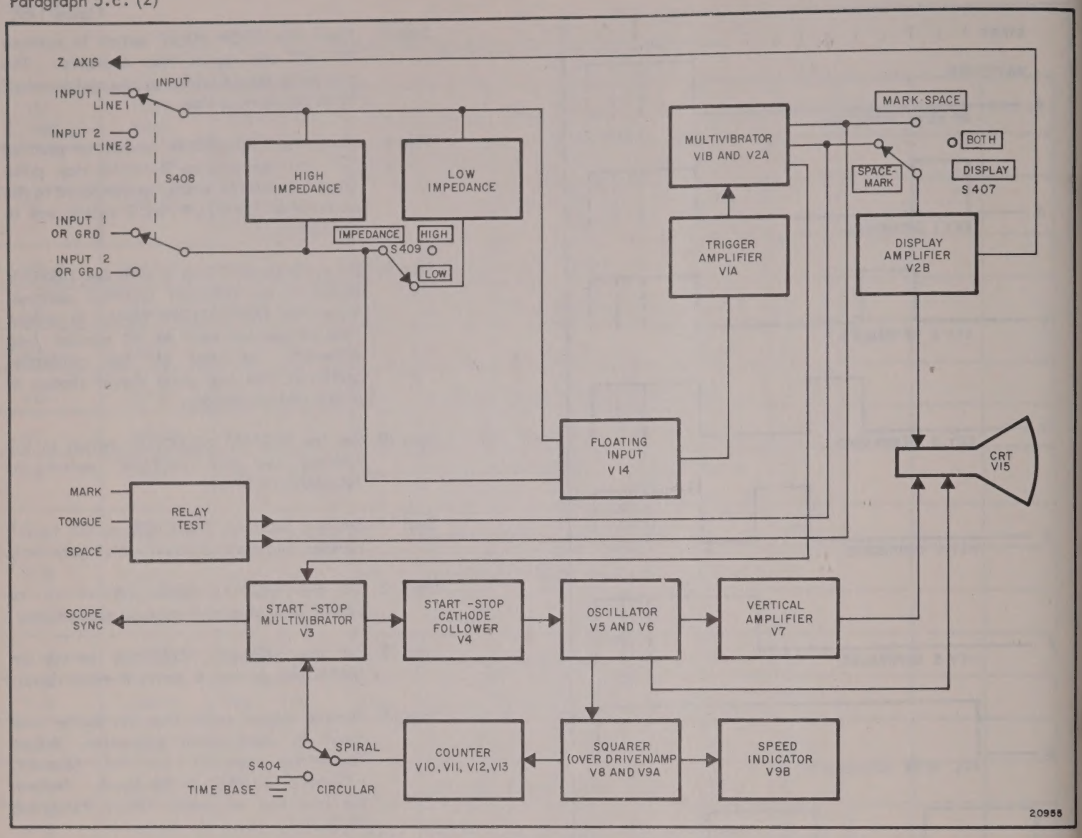


Figure 1-62. Receiver - Functional Block Diagram

(2) Receiver

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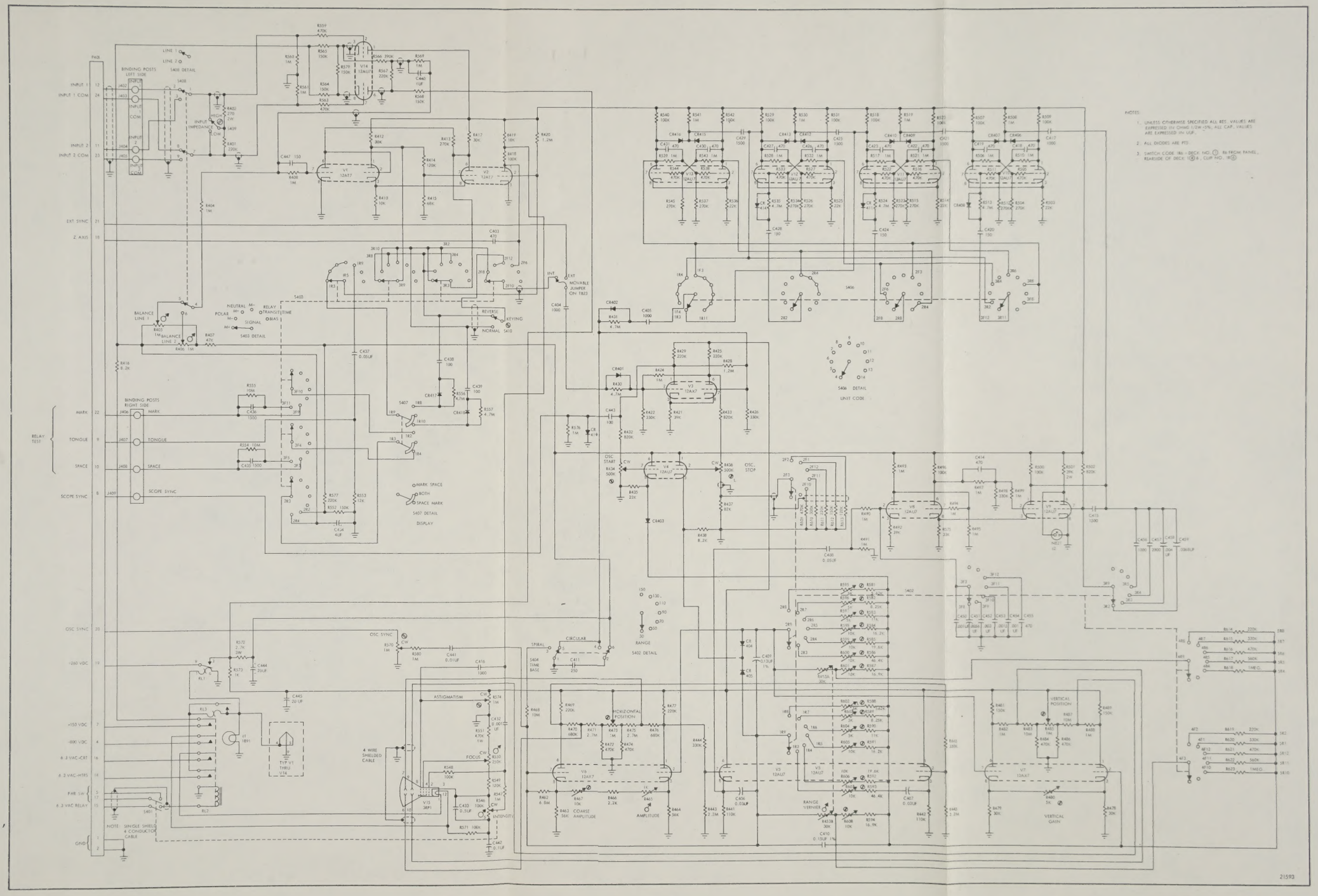

Figure 1-63. Receiver Schematic

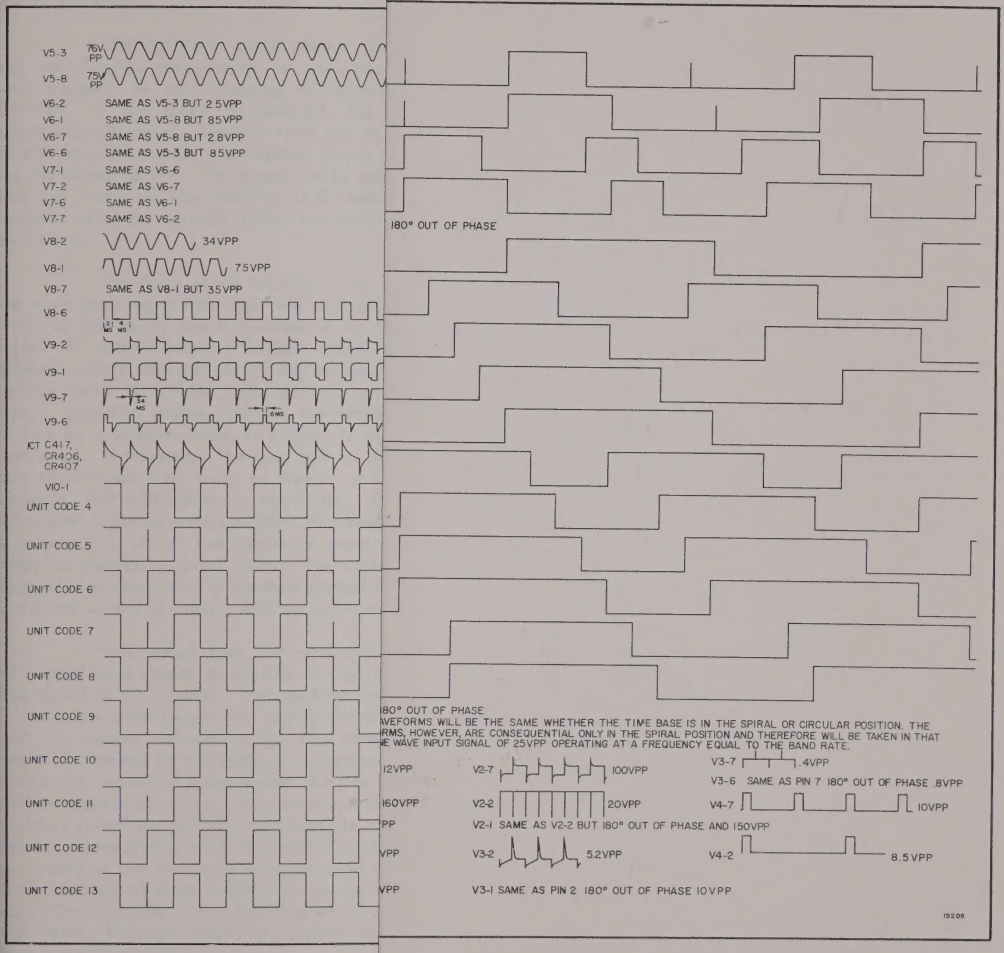

Figure 1-64. Receiver Waveforms

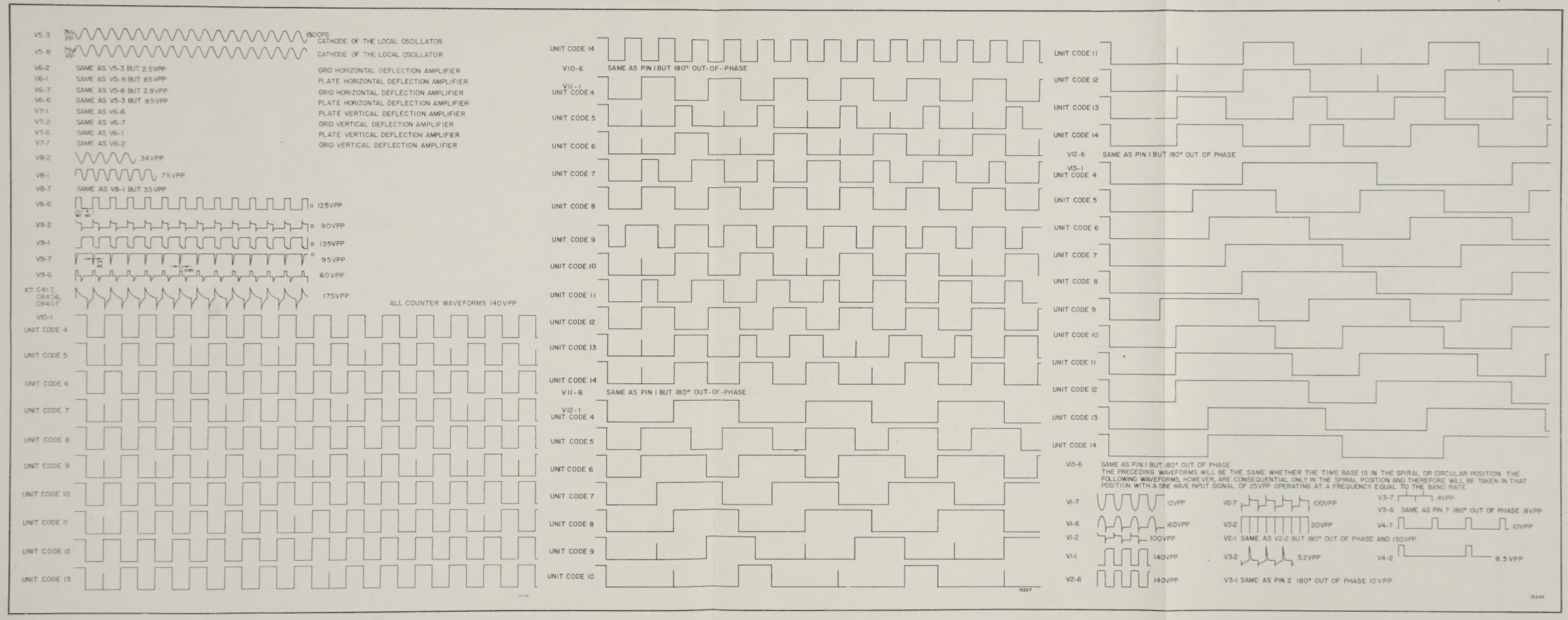

Figure 1-64. Receiver Waveforms

a row of vertical dots. Each dot is on a separate loop of the spiral.

Various types of distortion cause different displays. If the start element is lengthened or shortened, the first dot will not move, while the remaining dots will be angularly displaced to the right or left and the angular displacement will be constant for all displayed dots. However, distortion seldom is limited to one type; the display will usually contain displacement due to more than one type of distortion.

The DISPLAY switch permits the operator to read mark/space, space/mark, or both transitions. From these displays, he can determine the extent and type of distortion. If the speed is incorrect, the dots will be sequentially displaced. Reading from top to bottom, each dot will have an angular displacement which is more or less than the preceding one. The speed can be adjusted to bring these dots into a vertical line, but it is preferable to adjust the speed using the circular trace and then switch to the spiral trace.

The heart of the Receiver is a push-pull R-C sine wave oscillator which feeds two push-pull drivers. The drivers in turn supply two sine waves to the CRT deflection plates. A vertical amplifier circuit assures that the two deflection-plate voltages are 90 degrees out of phase: the resulting trace is circular. An oscillator control flip-flop, through clamping diodes, permits the oscillator to either run free for a circular trace, or triggers it on and off for a spiral trace. In this mode, the loop gain of the oscillator is made slightly less than unity so that it will not be self-sustaining, but will decay in amplitude. This causes the spot to start at the outer edge of the CRT screen as if it were to trace out a circle, and gradually move in toward the center to produce a spiral trace. The control flip-flop is triggered by the beginning of the start element of the incoming signal, and is reset by a pulse from the binary counter.

Sine waves from the oscillator are amplified and clipped by a shaper to provide an approximate square wave signal to the counter. The negative-going transitions of the square wave trigger the counter which can be set to count any number between 4 and 14, depending on the number of elements in the telegraph characters. At the end of the count, a positive pulse is sent from the counter to the oscillator control flip-flop. This acts as a reset pulse and the flip-flop turns off the oscillator and stops the spiral trace. In this way, the oscillator takes the place of a mechanical start-stop mechanism and is always in synchronism with the signal input. Each signal element transition produces a dot on the trace. On a circular trace, the dots would overlap; on the spiral trace, however, each dot appears on its own loop where it can be studied separately.

With a relay connected to the relay terminal, the SIGNAL switch is set for BIAS or TRANSIT TIME as desired; the DISPLAY switch is set to indicate either mark/space, space/mark, or both transitions of the signal; the TIME BASE switch is set to CIRCULAR. For bias checks, the negative voltage applied to the relay contact returns through the armature to the CRT control tube. This tube, though normally conducting, is cut off by the negative voltage from a contact closure. This raises the voltage on the CRT grid and causes a bright spot on the circular trace. With the Receiver synchronized with the relay-pulsing signal, two stationary dots, one for each contact, will appear. Adjusting the relay for zero bias superimposes the dots. For transit time and contact bounce measurements, a positive voltage is applied to mark and space contacts. During the transit time, a capacitor discharge applies a negative voltage to the CRT control tube and the trace is brightened. Contact bounce causes bright spots to occur at the end of the bright trace.

(d) Oscillator, V5, V6

Tubes V5 and V6 comprise the R-C type oscillator. The basic principle of this oscillator is the zero phase shift, resistance-capacitance feedback path around a push-pull amplifier. Tube V6 is the push-pull amplifier and V5 is a cathode follower which prevents any loading of the R-C phase-shifting network. Since V6 is a push-pull amplifier the plates are 180 degrees out of phase. The signal for driving the CRT horizontal deflection plates is taken from the plates of V6 through resistive voltage dividers. The HORIZ POS control varies the dc voltage on the horizontal deflection plates. The two amplitude controls in the cathode circuits of V6 control the gain of this stage.

The frequency of oscillation is controlled by the R-C network connected between the cathodes of V5. Resistor R453 (VERNIER) varies the frequency plus or minus 10 cps. Since the oscillator is a push-pull circuit, R453, a dual potentiometer, varies the frequency of each section simultaneously. R601 and R608 in series with the two sections of R453 set the frequency of oscillation for the 30-baud range. For all other baud ranges additional resistors are connected in parallel with R453 and pertinent resistors in series with it. The oscillator operates at the frequency indicated by the RANGE and VERNIER controls on the front panel. With TIME BASE switch S404 in the CIRCULAR position, the gain of the oscillator is greater than unity, so that the oscillator is free running. When this switch is in SPIRAL position, resistor R468 is connected from one grid of V6 (pin 7) to ground. This loads the amplifier so that the gain is reduced to less than unity. In this condition the amplitude of oscillator gradually decreases, so that successive circles traced on the CRT screen have a smaller diameter, resulting in the spiral presentation.

(e) Vertical Amplifier, V7

The vertical amplifier, V7, is driven by the oscillator; the output is then 90 degrees out of phase with the horizontal deflection plates. The vertical deflection plates are connected to the plates of V7 through resistive voltage dividers. The gain of this stage is controlled by the vertical gain control (R480, VERT AMP) in the cathode circuit of V7. The VERT POS control, R485, varies the dc potential on the vertical deflection plates.

(f) Squarer Circuit, V8A

The squarer circuit consists of an overdriven amplifier, V8A, which drives a Schmitt trigger circuit consisting of tubes V8B and V9A. The input to the squarer circuit is taken from the oscillator (pin 8, V5). This circuit converts the sine wave oscillator output to a square wave for driving succeeding circuits.

(g) Speed Indicator

The output of the Schmitt trigger is differentiated (by C415 and either C456, C457, C458 or C459, depending

on the speed range in use) and applied to the grid of V9B. The grid resistor (R502) of V9B is connected to high voltage so that V9B is operated at a slightly positive bias and conducts heavily. Owing to the resulting large drop across a plate load resistor (R501) the voltage across I-2 is insufficient to cause it to glow. The negative pulse from the differentiated waveform applied to the grid cuts off V9B and allows I-2 to fire.

(h) Counter, V10 through V13

The counter consists of four cascaded scale-of-two counters (flip-flop counters V10, V11, V12, V13) with feedback. A scale-of-two counter is a bistable multivibrator (stable in either of the two possible conditions), i.e., the left tube conducting and the right tube cut off or the right tube conducting and the left tube cut off. Each time the flip-flop receives a trigger pulse it reverses its condition. For example, if the left tube is conducting and the right tube is cut off, the condition of the two tubes will reverse. The next trigger pulse switches the tubes back to their original condition. It takes two trigger pulses to complete the cycle. Thus, the output frequency is half the input frequency. Even counts of 2, 4, 8 and 16 can be obtained from four scale-of-two counters connected in cascade. To obtain counts other than these, feedback circuits are introduced to advance the count of the earlier stages. This allows other counts to be realized (5, 6, 7, 9, 10, 11, 12, 13 and 14).

The counter is driven by the differentiated output of the Schmitt trigger which triggers the first flip-flop, V10, through diodes CR406 and CR407. The output of each flip-flop is then used to trigger the succeeding stages.

The division rate of the counter is determined by the position of the UNIT CODE switch, S406, which selects the feedback path used and the stage from which the output is taken. The division rate is variable over the range of 4 to 14. When the TIME BASE switch, S404, is in the CIRCULAR position, the output of the counter is grounded.

(i) Holding Circuit, V3A, V3B

The oscillator triggering, and the arrangement for stopping it at the end of a predetermined number of cycles, are achieved by the holding circuit. This circuit is comprised of a start-stop multivibrator, a pair of cathode followers, and two diodes used as a clamping circuit.

To arrange a triggered spiral time base it is necessary to make two modifications to the oscillator circuit utilized for the continuous circular trace. First, the loop gain of the oscillator circuit must be reduced to slightly less than unity so that the oscillator output will be a diminishing oscillation and give a spiral trace. Second, means must be provided to start the oscillator at the appropriate instant, in synchronism with the incoming signal, and to stop it again after the appropriate number of cycles. Since the loop gain of the oscillator circuit is less than unity, the oscillator cannot start itself so it must be released under voltage conditions approximating those applied to the peak of the oscillator waveform. The "run-down" from this condition, which will occur when the circuit is released, supplies the first quarter-cycle of the oscillation. Reduction in loop gain to slightly less than unity is achieved by insertion of R468 (by means of the TIME BASE switch, S404) between the grid of V6A and ground. This has the effect of loading the oscillator. Since the loop gain of the oscillator circuit has been set up, by the AMPLITUDE control, R465, to give a circular trace of approximately two inches in diameter when operating as a continuously running time base, this slight reduction in gain is just sufficient to give the desired decaying effect. The AMPLITUDE control should not be adjusted while the oscillator is functioning in the spiral mode.

The start-stop multivibrator consists of V3A and V3B connected as a bistable multivibrator. The operation of this circuit is such that one tube is normally conducting and the other cut off. Should the tube which is cut off be made to conduct, the other tube will immediately be cut off. The circuit is stable no matter which tube is conducting and will only change its state when triggered by an external signal. In this particular application, the circuit normally rests in the state where V3B is conducting and V3A is cut off. When an incoming signal is received the first mark/space changeover (the commencement of the start element) causes the input circuit to generate a positive-going pulse. This pulse is differentiated by C404 and applied to the grid of V3A through diode CR401 and causes V3A to conduct and V3B to cut off, releasing the clamp on the oscillator. The counter counts the cycles of oscillation and, after the predetermined number of cycles selected by the positioning of the UNIT CODE switch, generates a positive-going pulse. This pulse is differentiated by C405 and applied to the grid of V3B through diode CR402, causing the multivibrator to revert to its original state. This reapplies the clamping circuit, stopping the oscillator and holding it in a condition corresponding to the peak of an oscillatory cycle.

To make certain that the multivibrator starts in the proper condition when switching the TIME BASE switch, S404, from CIRCULAR to SPIRAL, C411 is connected to high voltage in the CIRCULAR position, causing it to charge to the high voltage potential. The resulting positive voltage applied to the grid of V3B (pin 7) causes this tube to conduct and thus clamp the oscillator until the next mark/space transition is received at the input. The proportion of the potentials appearing at the plates of the start-stop multivibrator, which are fed to the grids of the cathode followers, is made variable to control the potentials to which the oscillator is held. Resistors R434 (OSC START) and R436 (OSC HOLD) are adjusted so that the oscillator circuit is held in a condition corresponding to the peak of an oscillatory cycle.

The pulse appearing on the plate of V3A (pin 1) is also differentiated by C443 and fed to the SCOPE SYNC terminal. Diode CR419 clips the positive portion of the differential waveform so that the sync pulse output is a negative pulse. This permits an external oscilloscope (Tel-A-Scan) to be synchronized with the Receiver so that both units will display the same signal simultaneously.

(j) Input Circuit

Input connections to the Receiver may be made through either one of two sets of input terminals. The INPUT SEL switch, S408, selects the pair of input terminals to be connected to the Receiver. The high or low input impedance is determined by the position of the INPUT IMP switch, S409. In the HIGH impedance position a 220K ohm resistor, R401, is connected across the input terminals. In the LOW impedance position a 270 ohm resistor, R402, is connected

in across the line. The inputs connect to isolation stage V14 and then to the grid of V1A.

The isolation stage, V14, provides a ground reference for balanced or floating line (a line which has neither side grounded). This stage is the combination of cathode follower V14A and amplifier V14B. One side of the line is connected to the grid of the cathode follower and the other side is connected to the grid of the amplifier. The outputs of each of these stages are combined through resistors R566 and R567, resulting in a combined output of the same amplitude and phase as the input signal except that it is now referenced to ground. Any signal (hum pickup, cross-talk, etc.) that is the same phase and amplitude on each side of the line is cancelled.

Switching tube V1A is arranged to have a very small grid bias, enabling small values of input signals to cause the tube to fully conduct or to be completely cut off. This tube is directly coupled to a bistable multivibrator (V1B and V2A): positive inputs to V1A cause V1B to cut off and V2A to conduct; negative inputs to V1A cause V1B to conduct and V2A to cut off. Inputs to V1A must vary to both sides of a zero potential to cause the multivibrator to switch from one state to the other. The LINE BALANCE control, R405 and R406, corresponding to the input line being used is connected to the junction of R569 and R408; when the BALANCE control is varied the bias on V1A is varied. This allows V1A to be triggered on any portion of the input signal, thus permitting signal distortion to be analyzed at any point of the waveform.

When the SIGNAL switch, S403, is in the POLAR +M position, an output of the input multivibrator (plate of V2A) is connected through S403 to C404, which differentiates it and feeds it to the holding circuit (Paragraph (h). When S403 is in the POLAR -M position an output is taken from the plate of V1B and fed to the holding circuit. With S403 in the NEUTRAL +M position an output is taken from the plate of V2A and fed through the KEYING switch, S410, to the holding section (assuming S410 is in the normal position). When S403 is in the NEUTRAL -M position an output is taken from the plate of the V1B and fed through the KEYING switch, S410, to the holding circuit (assuming S410 is in the normal position). With the KEYING switch in the REVERSE position the signal fed to the holding circuits in the NEUTRAL +M and -M positions of the SIGNAL switch is taken from the opposite sides of the input multivibrator so that the start-stop multivibrator will be keyed by a signal of opposite polarity.

(k) Display Amplifier

Display amplifier V2B is operated with a slightly positive grid bias, as its grid resistor, R420, is returned to high voltage. This circuitry causes V2B to pass a fairly heavy current even though the plate voltage is low because of the voltage drop across R418 and R419. An output is taken from each side of the input multivibrator (plates of V1B and V2A) and differentiated by C438 and C439. The negative portion of the differentiated waveform is passed by diodes CR417 and CR418 through the DISPLAY switch, S407, to the grid of the display amplifier. The negative pulse of the grid cuts the tube off so that the plate voltage rises rapidly and a large positive pulse appears on the plate. Resistors R418 and R419 form a voltage divider for this pulse, causing only a portion of it to be coupled through capacitor C432 to the grid of the CRT. Because the positive pulses occur each time the input multivibrator switches (triggered by the input signal), a dot appears on the CRT screen for each transition of the input signal (assuming the DISPLAY switch, S407, is in the BOTH position). With S407 in the MARK/SPACE position, only the mark/space transitions are displayed; in the SPACE/MARK position, only the space/mark transitions are displayed.

(l) Relay Test

With DISPLAY switch S407 in the BOTH position, the SIGNAL switch S403 when set to BIAS connects a negative voltage through the DISPLAY switch to both C435 and C436. These capacitors are connected to the mark and space contacts of the relay under test. The tongue (armature) of the relay is connected through C437 to the grid of the display amplifier. When the tongue makes contact with the mark contact, current will flow through R553 and charge C436. R553 and C436 have a short RC time constant, which causes C436 to charge rapidly. This results in a short negative pulse across R553 which is coupled to the display amplifier through C437, causing a dot to appear on the screen. The same action occurs when the tongue makes contact with the space contact, except that C435 is used. If the relay is driven (by an external source) at half the modulation rate set up on the Receiver, the CRT trace will make one complete circle during the time it takes the tongue to traverse the distance from one fixed contact (mark or space) to the other. Thus, for a bias-free relay the two dots will occur superimposed on some point of the circle. If the relay takes longer to close one contact than the other, the dots will be separated.

When the SIGNAL switch, S403, is in the RELAY TRANSIT TIME position, a positive voltage from the voltage divider R577 and R552 is connected through the DISPLAY switch (in the BOTH position) to both the mark and space contacts of the relay under test. This applies a positive pulse across R553 whenever the tongue is in contact with one of the fixed contacts. During the time the tongue is traversing (transit time) from one contact to the other there is no voltage across R553. This positive pulse is coupled through C437 to the grid of the display amplifier V2B. C437 blocks the dc component of the signal so that the pulse goes both positive and negative at the display amplifier grid. The negative portion of this pulse occurs during the transit time of the relay causing a bright arc on the CRT; its length is a direct function of the relay's transit time. As in the bias test, the relay is driven at half the Receiver modulation rate. The arc corresponding to the transit time will be superimposed if the relay is bias free.

(m) Power Control Circuits

All voltages necessary for the operation of the Receiver are supplied by either the Rack-Mount Power Supply, Model 14-102/103D or the Portable Power Supply, Model 14-104B.

The "on-off" switch is a double-pole single-throw switch located on the back of the INTENSITY control (the "off" position is the PWR OFF setting). One side of this switch is connected in series with the ac power line, and one side of the primary of the power transformer in the associated power supply through pins 5 and 17 of P401. The other side of this switch connects the 6.3 vac from P401, pin 15, to relay RL2.

RL2 is a four-pole, single-throw relay switch which controls the application of power to the various Receiver circuits. One section of this relay connects -800 volts from P401, pin 4, to the CRT circuit. Another section connects the CRT filament from P401, pin 16. A third section connects -150 volts from P401, pin 7, to the Receiver circuit. A fourth section connects the 6.3 vac filament voltage from P401, pin 14, to all tube filaments, except the CRT, and to the delay relay RL1. The tube filaments are connected in parallel.

(n) High Voltage Circuits

High voltage for the various Receiver circuits is supplied through a thermal delay relay, RL1, from P401, pin 19. RL1 has approximately 30 seconds delay and is used to prolong the life of the tubes by allowing the filaments time to warm up before high voltage is applied to their plate circuits. The 260 volts from the power supply is fed through decoupling resistors R572 and R573. C444 is a bypass capacitor for R572; C445 is the bypass capacitor for R573.

(o) Troubles and Probable Solutions

The troubles and probable solutions listed in Table XIV have been selected because of their representative nature. Figures 2-24 through 2-43 of Section II and the resistances and voltage charts, Tables XV and XVI will prove helpful in locating faulty components.

(p) CRT Removal and Installation

WARNING

VOLTAGES DANGEROUS TO LIFE ARE PRESENT. DISCONNECT POWER WHILE HANDLING TUBE SOCKET.

TABLE XIV. RECEIVER TROUBLES AND PROBABLE SOLUTIONS

TROUBLE	SOLUTION
POWER indicator does not light and trace is not visible on the CRT.	Check line fuse in associated power supply. (See appropriate power supply). If this fuse is blown, check the power supply and Receiver for the cause before replacing. Check for shorts in the Receiver filament circuit and ac power switch circuit. If the line fuse is not blown, check PWR OFF switch and power control relay RL2.
POWER and SPEED indicators light but trace is not visible on the CRT.	Check the negative high voltage fuse in the Rack-Mount Power Supply, if used. Check the associated power supply for possible cause of failure of -800v circuit. Check RL2 for faulty contacts. Check the CRT for replacement.
POWER indicator lights, SPEED indicator does not light, and CRT has a bright dot in the center.	Measure the +260 vdc on pin 9 of RL1. If no voltage is present at this point see the associated power supply for possible cause of failure of +260v circuit. If +260 vdc is present at pin 9, RL1, measure the voltage at pin 3, RL1. If +260v is not present at this point replace RL1. If +260v is present at RL1-3 check R573 for open. If open, check the various B+ points in the Receiver for a short. Check C445 for short. If +260v circuit proves correct, check tubes V5 and V6. If tubes are good, check associated components in the oscillator circuit. Use the Resistance Chart, Table XV, and Voltage Chart, Table XVI, to help localize the faulty component.
POWER indicator lights, SPEED indicator does not light and CRT presentation normal on circular time base, but no spiral present on spiral time base.	Check tubes V8 and V9. If tubes are good, check components in squarer circuits. Use the Resistance and Voltage Charts, Tables XV and XVI, to locate the faulty component. If an oscilloscope is available the waveforms shown on Figure 1-64 can also be used to localize the trouble.
POWER and SPEED indicators light but CRT has only a horizontal line.	Check V7 and setting of VERT AMP control, R480. Check components in vertical amplifier circuit.
POWER indicator lights, SPEED indicator lights on CIRCULAR time base. Receiver operates normally on CIRCULAR time base, but no spiral is present on SPIRAL time base.	Check V3, V4, V10, V11, V12 and V13. If all tubes are good, check the components in the counter and holding circuits. Use the Resistance and Voltage Charts, Tables XV and XVI, to localize the trouble. If an oscilloscope is available, the waveforms shown in Figure 1-64 can be used to help localize the trouble.
CRT display normal for both the circular and spiral time base except that no bright dots are present.	Check V2 and associated components.
On circular time base the SPEED indicator lights and the CRT has a normal circle but no bright dots. On spiral time base spiral is not present.	Check V1, V2 and V14. If tubes are good, check the input circuits and the components associated with V1, V2 and V14. Use the Resistance and Voltage Charts, Table XV and XVI, and the waveforms to localize the trouble.

TABLE XV. RECEIVER RESISTANCE CHART

TUBES	PIN 1	PIN 2	PIN 3	PIN 4	PIN 5	PIN 6	PIN 7	PIN 8	PIN 9	PIN 10	PIN 11	PIN 12
V1	170K	2M	25K	0.15	0.15	1.1M	1.5M	10K	0			
V2	150K	1.2M	0	0.15	0.15	180K	1.2M	25K	0			
V3	180K	600K	40K	0.15	0.15	180K	750K	40K	0			
V4	50K	65 to 350K	40K	0.15	0.15	50K	0 to 325K	20K	0			
V5	50K	450K	110K	0.15	0.15	50K	470K	110K	0			
V6	230K	90K	30K	0.15	0.15	220K	90K	30K	0			
V7	240K	30K	30K	0.15	0.15	240K	90K	30K	0			
V8	500K	2M	40K	0.15	0.15	130K	1.5M	35K	0			
V9	150K	1.3M	35K	0.15	0.15	90K	900K	0	0			
V10	140K	700K	25K	0.15	0.15	140K	700K	25K	0			
V11	140K	700K	25K	0.15	0.15	140K	700K	25K	0			
V12	140K	700K	25K	0.15	0.15	140K	700K	25K	0			
V13	130K	700K	25K	0.15	0.15	130K	700K	25K	0			
V14	50K	2.2M	400K	0.15	0.15	180K	470K	420K	0			
V15	∞	2M	700K	420 to 700K	∞	650K	650K	0 to 280K	1.1M	1.1M	∞	900K
RL1	0.15	∞	∞	∞	∞	0	∞	50K	50K			

TABLE XVI. RECEIVER VOLTAGE CHART

TUBES	PIN 1	PIN 2	PIN 3	PIN 4	PIN 5	PIN 6	PIN 7	PIN 8	PIN 9	PIN 10	PIN 11	PIN 12
V1	115 v	15 v	30	6.3	6.3	45	-2	0.7	0			
V2	15	0.35	0	6.3	6.3	110	20	30	0			
V3	75	29	31	6.3	6.3	185	0	31	0			
V4	210	10 to 70	41	6.3	6.3	210	0 to 20	17	0			
V5	260	100	132	6.3	6.3	260	98	131	0			
V6	135	18	26	6.3	6.3	135	18	26	0			
V7	150	18	26	6.3	6.3	150	18	26	0			
V8	55	-6	3.2	6.3	6.3	106	36	48	0			
V9	160	21	50	6.3	6.3	38	-4	0	0			
V10	120	23	35	6.3	6.3	122	23	36	0			
V11	122	23	35	6.3	6.3	122	23	36	0			
V12	122	23	35	6.3	6.3	122	23	36	0			
V13	122	23	35	6.3	6.3	122	23	36	0			
V14	212	0	12	6.3	6.3	93	0	7	0			
V15	6.3	-570 v	-575	-360 to -540	0	126	128	0 to 260	120	125	0	-720
RL1	0	0	265	265	0	0	0	265	265			

Step 1 To remove the CRT place the Receiver unit on a bench.

Step 2 Remove the socket assembly from the base of the tube.

Step 3 Loosen two one-quarter turn fasteners and unfasten the clamp at the rear of the tube shield.

Step 4 Remove the screw supporting the front of the CRT shield.

Step 5 Lift the tube rearwards from the panel.

Step 6 Remove shield.

CAUTION

Do not bump or bend the CRT shield as the magnetic properties of the shield may be affected.

Step 7 To install the CRT insert the tube into the shield.

Step 8 Position the face of the tube against the cushion.

Step 9 Replace front supporting screw.

Step 10 Replace and fasten the clamp at the rear of the tube shield.

Step 11 Replace the socket assembly.

Step 12 To angularly adjust the CRT loosen the clamp at the rear of the tube shield.

Step 13 Turn the Receiver on and establish a bright, sharp, spiral sweep.

Step 14 Rotate the tube socket as necessary to make the spiral sweep start at the zero mark on the scale.

Step 15 Seat the tube against the cushion and fasten clamp.

(3) Tel-A-Scan

(a) Figures and Tables

Figure 1-65. Tel-A-Scan Block Diagram
Figure 1-66. Tel-A-Scan Schematic
Figure 1-67. Tel-A-Scan Waveforms
Figures 2-44 through 2-60 of Section II

Table XVIII. Troubles and Probable Solutions
Table XIX. Tel-A-Scan Resistance Chart
Table XX. Tel-A-Scan Voltage Chart

(b) Tools and Equipment

Electronic Tool Kit
Tube Tester
Tube Pin Straightener
Tube Puller
Multimeter (20,000 ohms per volt)
Oscilloscope
Signal Generator (audio)

(c) Tel-A-Scan Block Diagram Discussion

The Tel-A-Scan has been specially designed for use with automatic telegraph and low-speed data systems. It is shown in block diagram form in Figure 1-65 and in schematic form in Figure 1-66.

The sweep circuits employ a modified phantastron oscillator with 10 speed ranges covering sweep speeds from 30 microseconds through three seconds. A VERNIER control allows accurate selection of intermediate speeds on any of these ranges. The output of the phantastron oscillator feeds the grids of the push-pull horizontal amplifier which drives the horizontal deflection plates of the CRT. A magnifier stage is provided which, when inserted between the oscillator and horizontal amplifier, allows an eight-times magnification; a front panel control permits positioning of the magnified trace horizontally on the CRT. The unit's design incorporates a blanking circuit which, when triggered by the output of the phantastron oscillator, provides a blanking voltage which removes the retrace from the CRT.

Because of the requirement to sync firmly on the leading or trailing edge of low-speed signals, an elaborate synchronizing circuit has been devised. This circuit consists of three amplifiers and associated circuitry, including a switch which allows synchronizing the unit in either the positive or negative phase to 60 cycles, to the incoming signal, or to an external source.

The eight-position INPUT SEL switch allows observation of the various incoming signals. Five of these positions connect to input terminals LINE 1 through LINE 5 located on the rear of the associated power supply. The last three positions, INPUT 1, INPUT 2, and INPUT 1 and 2, connect to two jacks on the front panel; these allow the instrument to be used as a general purpose oscilloscope.

A four-position ATTENUATOR switch on the front panel attenuates the incoming signal by 1000, by 100, or by 10; in its fourth position the signal goes directly through the circuitry without attenuation. The three-stage, push-pull dc vertical amplifier provides a flat response down to 3 db or less at the high end of the range (from zero through 100 kc). These amplifiers provide differential inputs in the first five INPUT SEL positions; but in the last three, the amplifiers may be used as single-ended or differential inputs.

The calibration circuit adjusts the vertical positioning of the retrace which, when superimposed on the signal trace, allows amplitude measurements of incoming signals. The potentiometer that controls retrace positioning is calibrated; voltage read from this dial and multiplied by the setting of the ATTENUATOR switch indicates actual voltage present at any point on the CRT presentation.

(d) Horizontal Oscillator

The horizontal oscillator is a modified phantastron which yields a saw-tooth output. Oscillation speed is controlled by the capacitor and by the associated

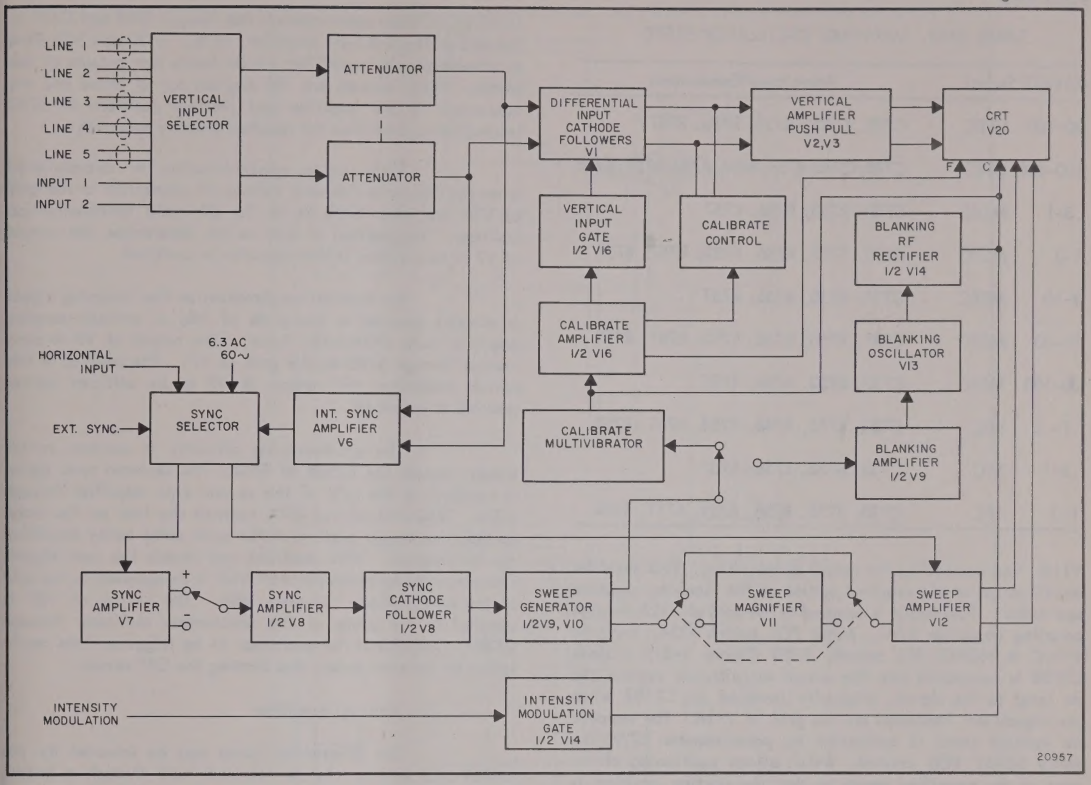

Figure 1-65. Tel-A-Scan - Block Diagram

resistor networks selected by the RANGE switch. In conjunction with this capacitor - resistor network VERNIER potentiometer R760, Figure 1-66, is provided to vary the voltage, and thus the speed, of the oscillator accurately within the selected range.

Table XVII indicates the associated components utilized by the various ranges of the RANGE switch.

Calibration of VERNIER control R760 is accomplished by varying R769 and R761 to allow conformance on all ranges selected. STABILITY control R751 permits the oscillator to be adjusted from free-running through varying degrees of receptivity to the synchronizing pulse. Turning the RANGE switch to its extreme counterclockwise position turns the oscillator section off to prevent pickup or interference while utilizing the horizontal amplifier input.

(e) Horizontal Amplifier

The saw-tooth output from the phantastron circuit is taken from the cathode of V9A and coupled to the grid of V12A, thence to the horizontal amplifier through the MAG POS switch and the resistive voltage divider comprised of R763 and R764 (Figure 1-66). The horizontal amplifier, comprised of V12A and V12B, is a cathode coupled amplifier, the incoming signal on the grid of V12A is amplified by that tube section and coupled from its cathode to the cathode of V12B through the SWEEP LG potentiometer R786. This arrangement provides outputs on the plates of V12A and V12B. These outputs are 180 degrees out of phase, providing opposite polarity of the saw-tooth for application to the horizontal deflection plates. The sweep-length potentiometer controls the gain of the horizontal amplifier.

The HORIZ POS control, R779, applies a dc voltage to the grid of V12B through the SYNC SEL switch, S753, allowing positioning of the CRT trace.

(f) Magnifier

When the MAG POS control is moved from the OFF position, it activates switch S754 which removes the output of the oscillator V9A from the horizontal amplifier and puts it on the grid of sweep magnifier tube V11A. This signal is applied through a voltage divider comprised of R765 and R766 and through a coupling capacitor, C735. The diode connected from the grid of V11A to ground is used to clamp the incoming saw-tooth at ground potential. The sweep amplifier is a two section stage: Section 1, V11A, is a cathode follower used to drive section 2, V11B, since these sections have a common cathode. Section 2 of the sweep magnifier contains the MAG POS control, R773 (Figure 1-66). This control allows bias adjustment of the V11B grid. Since this tube is biased near cutoff, this control allows amplification of a varying section of the incoming negative saw-tooth by

TABLE XVII. VARYING OSCILLATOR SPEED

RANGE Switch	Associated Components
30-100 USEC	C728, C729, R753, R756, R757
100-300 USEC	C728, C729, R755, R756, R753, R751, R758
.3-1 MSEC	C730, R753, R756, R757
1-3 MSEC	C730, R755, R756, R753, R757, R758
3-10 MSEC	C731, R753, R756, R757
10-30 MSEC	C731, R755, R756, R753, R751, R758
30-100 MSEC	C732, R753, R756, R757
.1-.3 SEC	C732, R755, R756, R753, R751, R758
.3-1 SEC	C733, R753, R756, R757
1-3 SEC	C733, R755, R756, R753, R751, R758

V11B, thus controlling the output at the plate. This provides amplification of the required portion of the incoming negative saw-tooth. This output is coupled to the grid of V12A through coupling capacitor C741, MAG POS switch S754, and the SYNC & HORIZ SEL switch, S753 (Figure 1-51). Diode CR703 is connected into the output circuitry to restore the dc level to the signal, originally removed by CR702 when the signal was impressed on the grid of V11A. The restored dc voltage level is controlled by potentiometer R777, the MAG START POS control, which allows positioning of the start of the magnified sweep so that the starting position is identical to the starting position of a normal sweep.

(g) Blanking

When the CALIB control is in its extreme CCW position, the calibrate circuits are disconnected and the blanking circuits are operative. A large negative pulse is taken from the screen grid of the phantastron sweep oscillator, V10, Figure 1-67, and coupled to the grid of the blanking amplifier, V9B, through R790. Resistor R791, connected to the grid of V9B, with R790 forms a voltage dividing network; this network sets the bias of the stage at zero. The negative pulse is initiated at the start of the retrace time, cutting off the blanking amplifier. This produces a large positive pulse at the plate of V9B, which is coupled to the screen and suppressor grids of blanking oscillator V13. This oscillator is normally biased to cutoff and the incoming pulse applied to the screen and suppressor grids allows the circuit to oscillate. These RF oscillations are link-coupled through L709 and L710 to the blanking rectifier, V14. The load for the blanking rectifier V14B is R798 and C749. These are connected to the CRT grid circuit. A negative pulse from the blanking rectifier cuts off the CRT during the retrace time.

(h) Synchronizing Circuits

Positive or negative external synchronization may be selected by the SYNC & HORIZ SEL switch, S753. Two parallel input connections are available: J704, on the front panel, and pin 12 on the barrier strip located on the rear of the associated power supply. A synchronizing pulse applied to either of these connections is fed through S753 and C725 to the grid of the first sync amplifier, V7A. V7A and V7B form a cathode-coupled amplifier which yields two outputs at the plates. These outputs are 180 degrees out of phase and are connected to the negative and positive positions of S753 respectively, providing the required polarity selection.

Sixty cycle synchronization is accomplished when the 60-cycle filament voltage is connected to the grid of V7A and when S753 is in the 60-cycle synchronization position. The position of this switch determines the output of V7 to be utilized (either negative or positive).

For internal synchronization the incoming signal is directly coupled to the grids of V6, a cathode-coupled amplifier with differential input. The output of V6 is connected through S753 to the grid of V7. The position of this switch determines the output of V7 to be utilized (either positive or negative).

The synchronizing circuitry is common to all inputs through the output of S753. The selected sync signal is coupled to the grid of the second sync amplifier through C726. TRIGGER control R744 controls the bias on the stage so that the proper portion of the sync pulse being amplified can be selected. V8A amplifies and inverts the sync signal. The output pulse at the plate of V8A is dc-coupled to the grid of the sync cathode follower, V8B. The output of V8B is coupled to the plate of the phantastron oscillator through CR701. This allows the oscillator to be triggered into oscillation by the sync pulse, thus starting the CRT sweep.

(i) Vertical Amplifier

Six differential inputs may be selected by the INPUT SEL switch. Inputs selected feed through a ladder attenuator (duplicate attenuator on each side of the dual inputs) to the grids of V1A and V1B, the vertical input cathode followers. The AC-IN/DC-OUT switch on the front panel inserts capacitors in series with the incoming signal lines in the AC-IN position. The DC BALANCE control, R719, in the cathode circuit of V1A and V1B allows matched dc balance of these two cathode followers. The VERT GAIN control, R716, connected between the two cathodes of these two cathode followers allows control of the vertical amplifier circuit gain. The outputs of the cathode followers are dc-coupled to the grids of the first vertical amplifier, V2, which is a dual triode connected in push-pull. The outputs of V2 are dc-coupled to the grids of the second vertical amplifier, V3, which is another dual triode connected as a push-pull amplifier. The VERT POS control, R726, (a part of the plate load of both sections of V2), varies the vertical position of the CRT display by varying the relative dc voltage on the grids of V3. The bias for the first vertical amplifier is adjusted by R722. C719, connected between the grids of V3, is used to compensate for variations in wiring and tube capacity. The outputs of V3 are connected directly to the vertical deflection plates of the CRT, V20. Resistors R734 and R735 provide feedback around the vertical amplifiers to stabilize the gain and reduce distortion.

(j) Calibration Circuitry

When the CALIB potentiometer, R815, is turned in a CW direction the calibrate circuits are activated; the blanking circuits are deactivated by S757. The negative pulse taken from the screen grid of phantastron V10 is

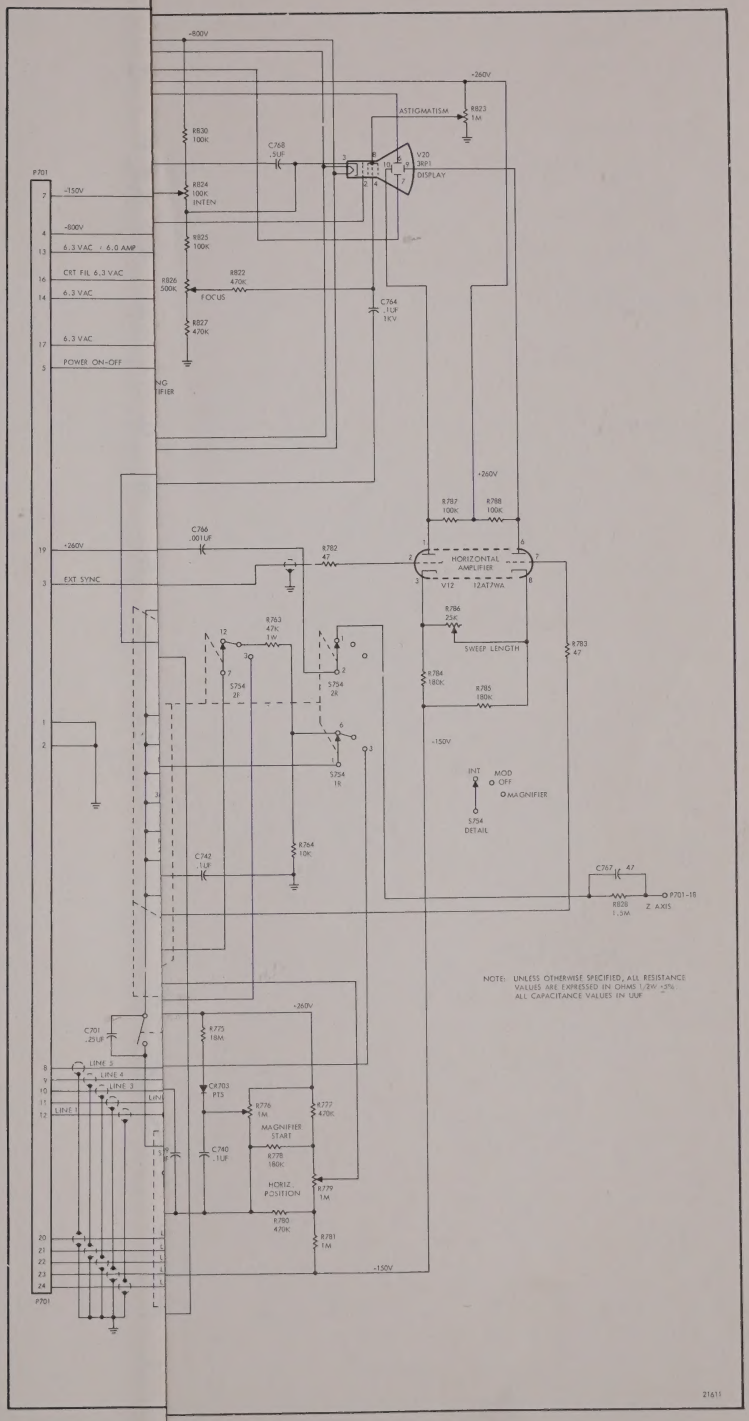

Figure 1-66. Tel-A-Scan Schematic

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(h) Synchronizing Circuits

Positive or negative external synchronization may be selected by the SYNC & HORIZ SEL switch, S753. Two parallel input connections are available: J704, on the front panel, and pin 12 on the barrier strip located on the rear of the associated power supply. A synchronizing pulse applied to either of these connections is fed through S753 and C725 to the grid of the first sync amplifier, V7A. V7A and V7B form a cathode-coupled amplifier which yields two outputs at the plates. These outputs are 180 degrees out of phase and are connected to the negative and positive positions of S753 respectively, providing the required polarity selection.

Sixty cycle synchronization is accomplished when the 60-cycle filament voltage is connected to the grid of V7A and when S753 is in the 60-cycle synchronization position. The position of this switch determines the output of V7 to be utilized (either negative or positive).

For internal synchronization the incoming signal is directly coupled to the grids of V6, a cathode-coupled amplifier with differential input. The output of V6 is connected through S753 to the grid of V7. The position of this switch determines the output of V7 to be utilized (either positive or negative).

The synchronizing circuitry is common to all inputs through the output of S753. The selected sync signal is coupled to the grid of the second sync amplifier through C726. TRIGGER control R744 controls the bias on the stage so that the proper portion of the sync pulse being amplified can be selected. V8A amplifies and inverts the sync signal. The output pulse at the plate of V8A is dc-coupled to the grid of the sync cathode follower, V8B. The output of V8B is coupled to the plate of the phantastron oscillator through CR701. This allows the oscillator to be triggered into oscillation by the sync pulse, thus starting the CRT sweep.

(i) Vertical Amplifier

Six differential inputs may be selected by the INPUT SEL switch. Inputs selected feed through a ladder attenuator (duplicate attenuator on each side of the dual inputs) to the grids of V1A and V1B, the vertical input cathode followers. The AC-IN/DC-OUT switch on the front panel inserts capacitors in series with the incoming signal lines in the AC-IN position. The DC BALANCE control, R719, in the cathode circuit of V1A and V1B allows matched dc balance of these two cathode followers. The VERT GAIN control, R716, connected between the two cathodes of these two cathode followers allows control of the vertical amplifier circuit gain. The outputs of the cathode followers are dc-coupled to the grids of the first vertical amplifier, V2, which is a dual triode connected in push-pull. The outputs of V2 are dc-coupled to the grids of the second vertical amplifier, V3, which is another dual triode connected as a push-pull amplifier. The VERT POS control, R726, (a part of the plate load of both sections of V2), varies the vertical position of the CRT display by varying the relative dc voltage on the grids of V3. The bias for the first vertical amplifier is adjusted by R722. C719, connected between the grids of V3, is used to compensate for variations in wiring and tube capacity. The outputs of V3 are connected directly to the vertical deflection plates of the CRT, V20. Resistors R734 and R735 provide feedback around the vertical amplifiers to stabilize the gain and reduce distortion.

(j) Calibration Circuitry

When the CALIB potentiometer, R815, is turned in a CW direction the calibrate circuits are activated; the blanking circuits are deactivated by S757. The negative pulse taken from the screen grid of phantastron V10 is

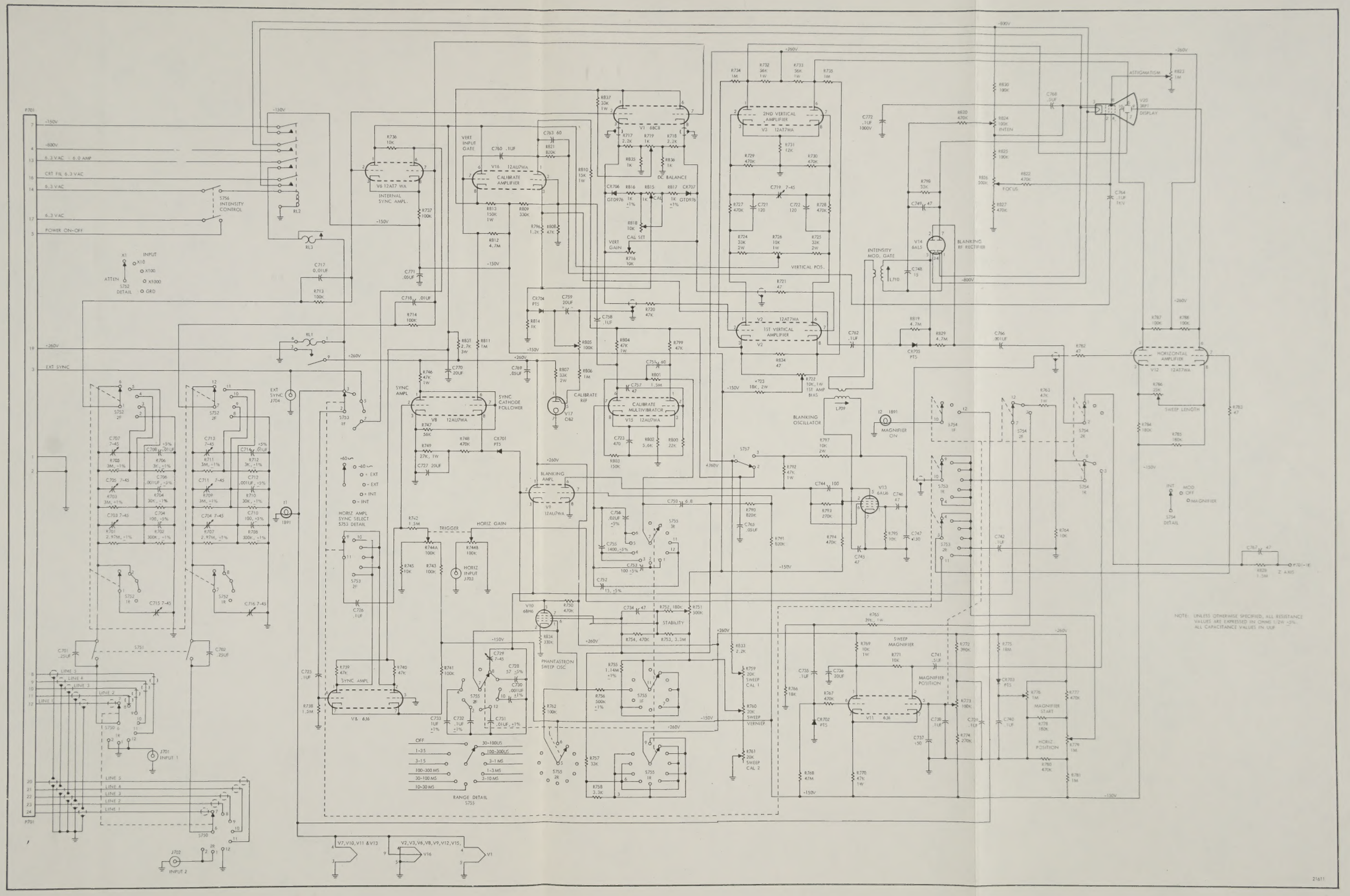


Figure 1-66. Tel-A-Scan Schematic

V PEAK-TO-PEAK APPLIED TO INPUT 1.
N AT MAX CW OR 1 INCH DEFLECTION ON CRT;

OUT OF PHASE

OUT OF PHASE

OUT OF PHASE

OUT OF PHASE

OUT OF PHASE

EL. SWITCH IN +INT. POSITION)

E OF WAVEFORM VARIES WITH SETTING OF TRIGGER CONTROL)
E OF WAVEFORM VARIES WITH SETTING OF TRIGGER CONTROL)

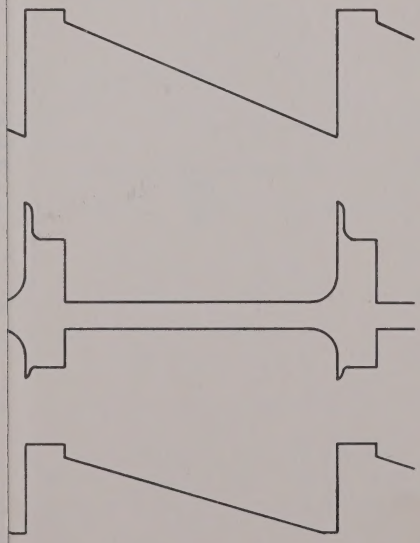


Figure 1-67. Tel-A-Scan Waveforms

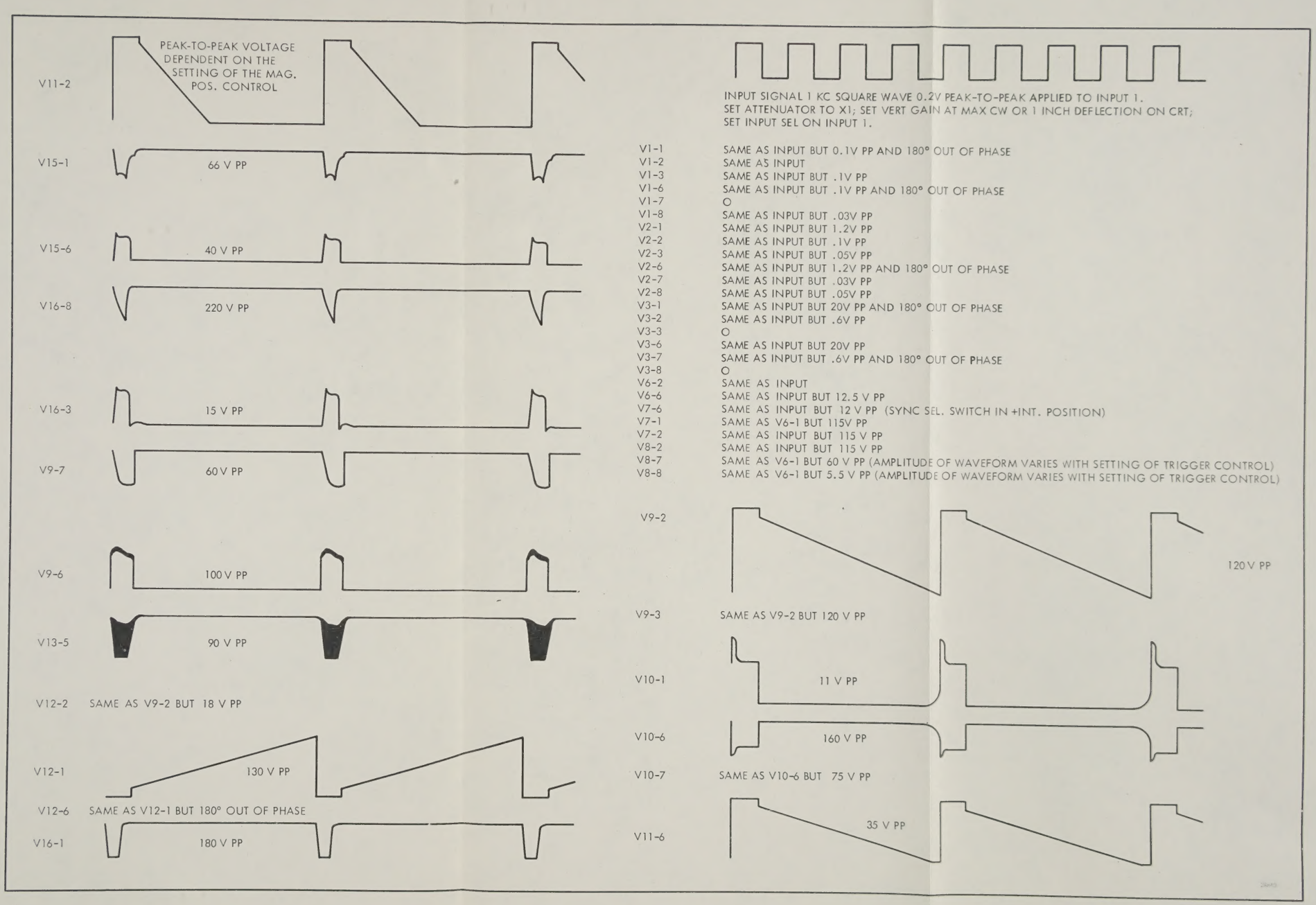
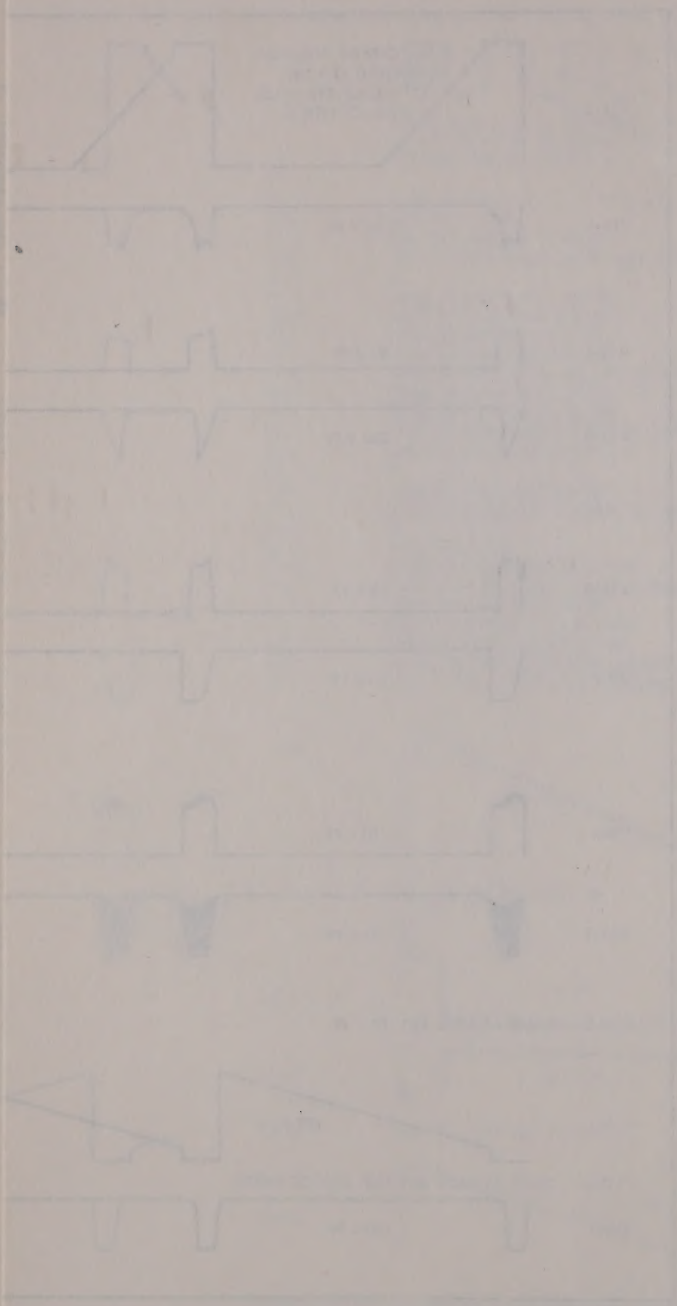


Figure 1-67. Tel-A-Scan Waveforms



differentiated by C750. This pulse triggers the calibration multivibrator, V15A, and V15B. The calibration multivibrator is a monostable stage with V15A normally conducting. The negative pulse applied to the plate of V15B causes V15A to cut off and V15B to conduct. The stage remains in this condition for the time determined by the R-C time constant selected by RANGE switch S755. Associated resistor R803, and the selection of the capacitors C756, C755, C753 and C752 or C751, control this time constant. The selection of multivibrator time constant matches the output of the multivibrator to the time of the retrace. The positive pulse on the plate of V15A is coupled to the grid of V16B through C758. V16B, the calibrate amplifier, has two outputs: one output is taken from its cathode and applied to the center arm of calibrate potentiometer R815; the other is taken from its plate circuit and coupled through C760 to V16A, the vertical input gate. The vertical input gate tube controls the voltage on the plate of V1, the vertical cathode follower stages. The large negative pulse on the grid of V16A cuts this tube off, thus removing the plate voltage from V1 and effectively blocking the incoming signal from the vertical amplifiers, allowing presentation of a clean retrace. The amplitude of the pulse from the cathode of V16B is controlled by potentiometer R805, since this potentiometer sets the level at which diode CR704 conducts. With R815 in its mid-range position the pulse goes through the center arm and provides equal potentials to both tubes. With these equal pulses on the grid of the first vertical amplifier, the retrace is positioned in the center of the tube. Repositioning this potentiometer to any other position results in an unbalance of the vertical amplifiers and a corresponding repositioning of the retrace. The positive pulse from the cathode of V16B also feeds through capacitor C762 and diode CR705 to the control grid of the CRT to brighten it during the retrace. In addition, a negative pulse is taken from the plate of V16B and fed through an attenuator network, R821 and C763, to the focusing anode to aid in focusing the retrace.

(k) Intensity Modulation

A positive pulse applied to pin 11 of the 12-pin barrier strip of the associated power supply is fed through attenuator C767 and R828 to the magnifier positioning switch, S754, then through capacitor C766 to the plate of V14A. V14A, the intensity modulation gate, passes the positive pulse to the control grid of the CRT, resulting in a bright dot on the face of the CRT.

NOTE

For calibration and balancing procedures refer to Paragraph 5 d (3).

(l) Troubles and Probable Solutions

The troubles and probable solutions listed in Table XVIII are representative in nature.

TABLE XVIII. TEL-A-SCAN TROUBLES AND PROBABLE SOLUTIONS

TROUBLE	SOLUTION
POWER indicator lamp does not light and no trace on CRT screen.	Check line fuse in associated power supply. (See appropriate power supply paragraph). If this fuse is blown, check the power supply and Tel-A-Scan for the cause before replacing. Check for shorts in the Tel-A-Scan filament circuit and ac-power switch circuit. If the line fuse is not blown, check PWR OFF switch and power control relay RL2.
POWER indicator lights but no trace visible on the CRT.	Check the negative high voltage fuse (F5) in the Rack-Mount Power Supply, or F2 in the Portable Power Supply. Refer to the associated power supply paragraph for possible causes of failure of -800 v circuit. Check RL2 for faulty contacts. Check the CRT. Check vertical amplifier circuit (V1, V2, V3). Check horizontal amplifier circuit (V12).
POWER indicator lights, CRT has only a bright dot in center of screen.	Measure the voltage at pin 9 of RL1 for +260 vdc. If no voltage is present see the associated power supply paragraph for possible cause of failure of +260 v circuit. If +260 vdc is present at pin 3 of RL1, measure the voltage at pin 9 of RL1. If +260 v is not present at this point, replace RL1. If +260 v is present at RL1 pins 3 and 9, check R831 for open. If open check the various B+ points in the Tel-A-Scan for a short. Check C770 for short. If +260 v circuit proves satisfactory check tubes V9, V10 and V12 and associated components. Use the resistance chart, Table XIX, and voltage chart, Table XX, to help localize the faulty component.
Indicator light lights but no trace appears on CRT. When the STABILITY control is turned CW, trace appears, but when this control is turned CCW until trace just disappears no setting of the TRIGGER control will produce a trace, regardless of the setting of the SYNC & HORIZ SEL switch.	Check tubes V7 and V8. If tubes are good check associated components. Use the resistance and voltage charts to localize the trouble.
Indicator light lights and unit operates normally,	Check tubes V9, V13 and V14. If tubes are good check associated components. Use the resistance and voltage charts to

TABLE XVIII. TEL-A-SCAN TROUBLES AND PROBABLE SOLUTIONS (Continued)

TROUBLE	SOLUTION
but retrace is visible when CALIB control is in full CCW position.	localize the trouble.
Indicator light lights but CRT display is obviously larger above or below center line	Check V1, V2, and V3. If tubes are good check associated components. Use the resistance and voltage charts to localize the trouble.
Indicator light lights and unit operates normally until the MAG POS control is moved to the operating position.	Check tube V11. If tube is good check associated components.

(m) CRT Removal and Installation

WARNING

VOLTAGES DANGEROUS TO LIFE ARE PRESENT. MAKE SURE POWER IS DISCONNECTED WHILE HANDLING TUBE SOCKET.

Step 1 To remove the CRT place the Tel-A-Scan on the bench.

Step 2 Remove the screw supporting the CRT shield at the front.

Step 3 Remove the socket assembly from the base of the tube.

Step 4 Unfasten the clamp at the rear of the tube shield.

Step 5 Lift the tube away from the panel.

Step 6 Remove shield from the tube.

TABLE XIX. TEL-A-SCAN RESISTANCE CHART

TUBES	PIN 1	PIN 2	PIN 3	PIN 4	PIN 5	PIN 6	PIN 7	PIN 8	PIN 9	PIN 10	PIN 11	PIN 12
V1	230K	1.1M	2.2K - 3.2K	0.15	0	230K	1.1M	2.2K - 3.2K	∞			
V2	60K	1.3K	100K	0.15	0.15	50K	1.4K	100K	0			
V3	70K	245K	12K	0.15	0.15	70K	245K	12K	0			
V6	20K	1.1M	180K	0	0	30K	1.1M					
V7	60K	60K	0	0.15	0	1.5M	180K					
V8	30K	1.5M	0	0	0	20K	30K	25K	0.15			
V9	20K	500K	50K	0	0	60K	440K	0	0.15			
V10	1.6M	330	0	0.15	500K	50K	180-300K					
V11	30K	40K	0	0.15	220K	3K	130K					
V12	110K	10K	180K	0	0	120K	360K	180K	0.15			
V13	10K	200K	0	0.15	30K	60K	0					
V14	1.6M	7.5M	1.2M	1.2M	1.5M	∞	1.5M					
V15	1.6M	25K	5.6M	0.15	0.15	1.6M	150K	5.6K	0			
V16	1.7M	40K	2K	0.15	0.15	25K	850K	230K	0			
V17	0	∞	0	50K	∞	0						
V20	1.2M	1.6M	1M	950K 1.5M	∞	70K	70K	230K	120K	120K	∞	1.2M
RL1	0	∞	∞	∞	∞	0	850K	20K	20K			

Note: V13, 14, 15, 16, and 17 resistances are taken with the CALIB switch turned off.

TABLE XX. TEL-A-SCAN VOLTAGE CHART

TUBES	PIN 1	PIN 2	PIN 3	PIN 4	PIN 5	PIN 6	PIN 7	PIN 8	PIN 9	PIN 10	PIN 11	PIN 12
V1	150v	0v	4.3v	6.3 vac	0v	150v	0v	4.3v	0v			
V2	75v	4.3v	4.4v	6.3 vac	6.3 vac	75v	4.3v	4.4v	0v			
V3	153v	31v	41v	6.3 vac	6.3 vac	145v	31v	41v	0v			
V6	215v	0v	4.4v	0v	0v	205v	0v	4.4v	6.3 vac			
V7	180v	180v	0v	6.3 vac	0v	0v	4v					
V8	110v	-0.4v	0v	0v	0v	250v	110v	115v	6.3 vac			
V9	250v	118v	125v	0v	0v	90v (1)	-30v(1)	0v (1)	6.3 vac			
V10	1.9v	1.7v	0v	6.3 vac	117v	55v	-76 to +50v					
V11	215v(2)	230v (2)	0v (2)	6.3 vac (2)	42v (2)	-0.2v(2)	-0.15(2)					
V12	125v	21v	23v	0v	0v	185v	4.3v	17v	6.3 vac			
V13	-5.5v(1)	-2.6v (1)	0v (1)	6.3 vac (1)	185v(1)	90v (1)	0v (1)					
V14	-640v	-640v	-780v	-640v	NC	-640v						
V15	245v(3)	0v (3)	21v (3)	0v	0v	65v(3)	20v(3)	21v (3)	6.3 vac			
V16	245v(3)	-18v (3)	1v (3)	0v	0v	217v	150v	155v	6.3 vac			
V17	110v	0v	0v	0v	110v	0v	0v					
V20	-730v	-625v	-610v	-265 to -540v	NC	153v	145v	0 to 260v	65 to 250v	75 to 240v	NC	730v
RL1	0v	NC	260v	NC	NC	0v	NC	NC	260v			

(1) With CALIB switch off. (2) With MAGNIFIER off. (3) With CALIB switch on.

CAUTION

Do not bump or bend the shield as the magnetic properties will be affected.

Step 7 To install the CRT insert the tube into the shield.

Step 8 Position the face of the tube against the cushion.

Step 9 Replace the screw supporting the front of the shield.

Step 10 Replace the socket assembly.

Step 11 Turn on Tel-A-Scan and rotate tube until the trace is parallel with the horizontal line on the graticule.

Step 12 Fasten the clamp at the rear of the tube shield.

(4) Rack-Mount Power Supply

(a) Figures and Tables

Figure 1-68. Rack-Mount Power Supply Schematic.
Figures 2-61 through 2-70 of Section II.

Table XXI. Rack-Mount Power Supply Resistance Chart.
Table XXII. Rack-Mount Power Supply Voltage Chart.

(b) Tools and Materials

Electronic Tool Kit
Tube Puller
Brush, stiff bristle (non-metallic)
VTVM
Multimeter
Tube Tester
Variable Autotransformer (0 to 150 volts)
Decade Box (100 w)
Oscilloscope

(c) 260-volt Circuit

Figure 1-68 is the reference illustration for this power supply discussion. The power supply consists of four separate regulator circuits and two 6.3 vac filament circuits that furnish all of the operating voltages required by the three primary TDMS units.

The +260 vdc supply consists of bridge rectifier diodes CR2, CR3, CR4, and CR5; filter capacitors C1 and C2; series regulator V1; amplifier V2; and reference tube V4.

The output voltage of the supply is adjusted to +260 vdc by potentiometer R11. One end of R11 is connected to +260 vdc through R10, and the other end is connected to the -105 vdc reference voltage through R12. The grid of V2 is connected to the center arm of R11, so that the setting of R11 controls the bias on V2. The grids of V1 are connected to the plate of V2, so that the bias on them is determined by the amount V2 conducts. V1 is a cathode follower, in that the voltage at the cathode "follows" the grid voltage.

If the +260v line increases for some reason (115 vac line surge or decrease in load) a portion of this positive change in voltage would be applied to the grid of V2 through resistors R10 and R11. This would cause V2 to conduct more; decreasing the voltage on the grids of V1. This, in turn, causes V1 to conduct less, lowering the output voltage to the original value.

Capacitor C4 is for ac feedback protection. Any ac voltage on the +260 vdc line is coupled through C4 to the grid of V2, where it is amplified and inverted. The amplified and inverted ac cancels out the original ac.

(d) -150 Volt Circuit

The -150 vdc supply consists of rectifier diode CR6, filter capacitor C5, regulator tube V3, reference tube V4, and zener diode CR7.

The operation of the -150 volt regulator is the same as that for the +260 volt regulator, except that the ground reference point has been moved to the positive side of the regulator and the regulation is accomplished by connecting the change in voltage directly to the cathode through CR7, instead of to the grid of the amplifier. CR7 is a zener diode. That is, it has a constant voltage across it.

(e) 450 Volt Circuit

The +450 vdc supply consists of half wave rectifier CR1 and filter capacitor C1. The 450 volt supply is actually an 80 volt supply with the negative side referenced to the unregulated source, 380 volts, for the 260 vdc supply.

(f) -800 Volt Circuit

The -800 vdc circuit consists of rectifiers CR10, CR11, CR12, and CR13; filter capacitors C8 and C9; series resistor R36; and shunt regulators VR1 through VR11.

The rectifiers are connected in a full-wave, voltage-doubler circuit. During one half cycle of the ac input waveform, C8 is charged through CR10 and CR11; and during the other half cycle C9 is charged through CR12 and CR13. C8 and C9 are connected in series, so that the total voltage across them is equal to the sum of their respective voltages. The positive side of the voltage doubler is referenced to the -150 vdc line instead of to ground. The output of the doubler is fed through R36 to the regulators VR1 through VR11. VR1 and VR11 are gas filled tubes that maintain a constant voltage drop across them with a varying current through them. If the load current varies, the regulators draw more or less current, as needed, to maintain a constant voltage. If load current decreases the regulator current increases. If the ac line voltage increases the output of the doubler will increase, but the neons will draw more current so that the increased voltage is dropped across R36.

Also, one side of the 6.3 vac for the CRT filaments is connected to the -800 vdc line.

(g) Troubleshooting Procedure

WARNING

REMOVE POWER PLUG FROM OUTLET BEFORE MAKING CHECKS DESCRIBED IN STEPS 1 THROUGH 6.

Step 1 Total Failure. Check fuse F4, Transformer T1, and PWR OFF switch in associated unit. If fuse is blown check for a short circuit in the power supply or associated units.

Step 2 +450 Volt Failure. Check fuse F3, diode CR1 and capacitor C1. Check transformer T1, pins 7 and 8. Check resistance from pin 6 of J10 to ground. The reading should be 3M megohms. Check pin 19 of J10 for +260 volts. If +260 volts are not present, see Step 3. (See Tables XXI and XXII.)

Step 3 +260 Volt Failure. Check fuse F1, diodes CR2, CR3, CR4, and CR5. Check tubes V1, V2, and V4, together with their associated components. Check transformer T1, pins 3 and 4. Check resistance from pin 19 of J10 to ground. The reading should be ∞ ohms. Check pin 7 of J10 for -150 volts. If -150 volts are not present, see Step 4.

Step 4 -150 Volt Failure. Check fuse F2, diode CR6, tubes V3 and V4, and associated components. Check resistance of pin 7 of J10 to ground. The reading should be ∞ ohms.

Step 5 -800 Volt Failure. Check fuse F5 and voltage regulators VR1 through VR11. Check condensers C7 and C8 and resistor R36. Check diodes CR8, CR9, CR10, and CR11. Check resistance from pin 4, J10 to ground; the reading should be 2.1 megohms.

Step 6 CRT Filament Voltage. Check continuity between pins 15 and 16 of T10; these pins should show no continuity to ground. A check between pin 16 of T10 and pin 4 of J10; and pin 15 of T10 and pin 16 of J10 should show continuity.

TABLE XXI. RACK-MOUNT POWER SUPPLY RESISTANCE CHART

REF. SYMBOL	TUBE TYPE	PIN 1	PIN 2	PIN 3	PIN 4	PIN 5	PIN 6	PIN 7	PIN 8	PIN 9
V1	6080	∞	110 K	∞	∞	110 K	∞	∞	∞	
V2	6AU6	∞	0	0	0.03 K	∞	94 K	0		
V3	5687	∞	∞	0	∞	∞	∞	∞	∞	∞
V4	0B2	0	∞	∞	∞	0	∞	∞		
J10, J11 or J12	Pin	1 0	2 0	3 ∞	4 ∞	5 ∞	6 3M	7 ∞	8 ∞	
	Pin	9 ∞	10 ∞	11 ∞	12 ∞	13 0.03 ohm	14 0.03 ohm	15 0.03 ohm	16 ∞	
	Pin	17 ∞	18 ∞	19 ∞	20 ∞	21 ∞	22 ∞	23 ∞	24 ∞	

TABLE XXII. RACK-MOUNT POWER SUPPLY VOLTAGE CHART

REF. SYMBOL	TUBE TYPE	PIN 1	PIN 2	PIN 3	PIN 4	PIN 5	PIN 6	PIN 7	PIN 8	PIN 9
V1	6080	205 v	395 v	265 v	205 v	395 v	265 v	260 v	260 v	
V2	6AU6	3.5 v	0 v	6.3 v	0 v	205 v	107 v	0 v		
V3	5687	140 v	-4.3 v	0 v	-105 v	-105 v	140 v	-145 v	-105 v	-4.3 v
V4	0B2	0 v	-105 v	0 v	-105 v	0 v	0 v	-105 v		
J10, J11 or J12	Pin	1 0	2 0	3 0	4 -800*	5 0	6 455 v	7 -150 v	8 0	
	Pin	9 0	10 0	11 0	12 0	13 6.3 vac	14 6.3 vac	15 6.3 vac	16 -800*	
	Pin	17 0	18 0	19 260 v	20 0	21 0	22 0	23 0	24 0	

* Voltage between pins 4 and 16 is 6.3 vac

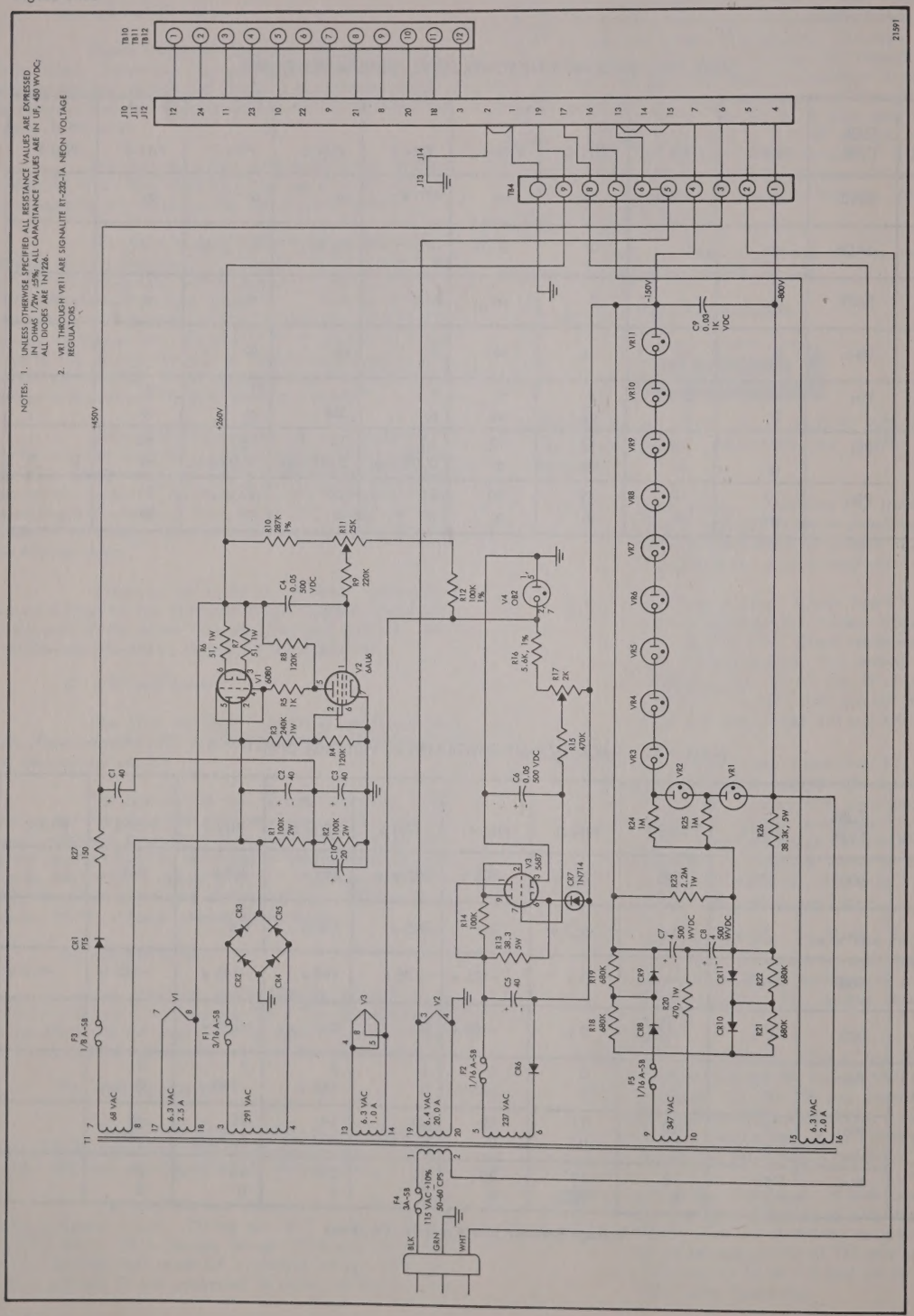


Figure 1-68. Rack-Mount Power Supply Schematic

Step 7 AC Ripple Present on -150 Volt Circuit.

NOTE

Ripple is normally caused by a filter component or diode failure. This condition can be checked with power on by connecting an ac vacuum - tube voltmeter or oscilloscope between the dc source and ground. When the dc circuit containing the ripple has been isolated the following steps should be taken.

CAUTION

Use a 1000-volt, 0.25 mfd capacitor in series with probe when checking ripple on the -800 volt circuit.

With power off test tubes V3 and V4 on a tube tester. Check diode CR5 for a front-to-back ratio of 10 ohms to 10 megohms. C4 must read at least 100K ohms between terminals after fuse F2 has been removed.

Step 8 AC Ripple Present on -800 Volt Circuit. With power applied, the voltage regulators VR1 through VR11 should light. If they do not light, remove power and discharge C8 and C9 by shorting pin 4, J10 to ground. Make the following ohmmeter tests:

a. Check diodes CR8, CR9, CR10, and CR11. All should have the same front-to-back ratio, 10 ohms to 10 megohms.

b. Check R23, R24, R25, and R26 for changing values.

c. Check C7 and C8; these capacitors should read at least 100K ohms.

NOTE

If voltage regulators are illuminated but flickering when power is on, remove power, discharge condensers, and check C7 and C8 or check power source for varying voltage.

Step 9 AC Ripple Present on 450 Volt Circuit. With power off, check diode CR1 for correct front-to-back ratio, 10 ohms to 10 megohms. Remove fuse F3 and check C1; it should read 100K ohms or more across the capacitor.

Step 10 Poor Regulation on +260 Volt, Pin 19, J10. Remembering that the regulated voltage uses the -150 volt circuit as a reference point, first check from pin 7, J10 for -150 volts to ground. Assuming this voltage present and correct, perform the tube check in Step 7. If these tubes prove to be conducting properly, check resistors R1 through R12 and capacitors C2, C3, and C4.

Step 11 Proper Operation. As a final test for proper power supply operation, connect a variable autotransformer between the input source and the power supply. Connect decade boxes or variable resistors from the terminals shown below to ground. Make certain that the wattage rating of the resistors is sufficient to handle the currents listed. Adjust the autotransformer to 105 vac and adjust the loads to the values given. The voltage at each terminal should be within the tolerances specified.

NOTE

If the necessary load resistors are not available, the three primary TDMS units may be used as a substitute. Use just the Receiver for the tests made at 125 vac input and all three units (Receiver, Transmitter, and Tel-A-Scan) for the tests made at 105 vac.

Terminals (J10, J11, or J12)	Load Resistance	Current	Voltage
7	7.5K	20 ma	-150 ± 7.5v
4	270K	3 ma	-800 ± 80v
6	11.3K	40 ma	+450 ± 50v
19	1.3K	200 ma	+260 ± 5v

Readjust the line voltage to 125 vac and reset the load resistors to the values shown in the following chart. The voltages at each terminal should be within the specified tolerance.

Terminals (J10, J11, or J12)	Load Resistance	Current	Voltage
7	50K	3 ma	-150 ± 7.5v
4	830K	1 ma	-800 ± 80v
6	45K	10 ma	+450 ± 50v
19	8.4K	31 ma	+260 ± 5v

(5) Portable Power Supply

(a) Figures and Tables

Figure 1-69. Portable Power Supply Schematic
Figures 2-71 through 2-80
Table XXIII. Portable Power Supply Resistance Chart
Table XXIV. Portable Power Supply Voltage Chart

(b) Tools and Materials

Electronic Tool Kit
Tube Puller
Brush, stiff bristle (non-metallic)
VTVM
Multimeter
Variable Autotransformer (0x to 150x volts)
Decade Box (50w)
Oscilloscope
Tube Tester

(c) 260-Volt Circuit

The +260-volt supply consists of reference tube V3, amplifier V2, series regulator V1, and the filter and rectifier described in (e) below. (See Figure 1-69)

(d) -150-Volt Circuit

The -150-volt supply consists of the -150v regulator V3, pi-filter C8, L2, and C9, and half-wave rectifier CR9.

(e) 450-Volt Circuit

The +450-volt supply consists of a full-wave rectifier and a choke-input filter. The full-wave rectifier consists of diodes CR1, CR2, CR3, CR4, CR10, and CR11, and the choke-input filter consists of L1 and series capacitors C3 and C10.

(f) -800-Volt Circuit

The -800-volt supply consists of high-voltage regulators VR1 through VR12, filter C5, R10, R11, and C6, and a voltage-doubler consisting of CR5 through CR8.

NOTE

The ac filament voltage for the CRT is taken from pins 8 and 9 of T1. The ac filament voltage for the tubes is taken from pins 12 and 13 of T1.

(g) Troubleshooting Procedure

WARNING

MAKE CHECKS IN STEPS 1 THROUGH 7 BELOW WITH POWER OFF.

Step 1 Total Failure. Check fuse F1, transformer T1, and PWR OFF switch of INTENSITY control on the attached TDMS unit.

Step 2 +450V Circuit Failure. Check fuse F2 (Figure 1-35), diodes CR1, CR2, CR3, CR4, CR10, and CR11; check choke L1 (Figure 1-34); check transformer T1, pins 3 and 5. Check resistance from pin 6 of J1 to ground; reading should exceed 100K ohms. (See Tables XXIII and XXIV.)

Step 3 +260V Circuit Failure. Repeat the checks described above. Check tubes V1, V2, and V3 (Figure 1-35) with a tube tester. Check resistance from pin 19 of J1 to ground; reading should be in excess of 750K ohms.

Step 4 -150V Circuit Failure. Check tube V3 (Figure 1-35), capacitor C8, choke L2, and capacitor C9. Check diode CR9 and fuse F3 as well as resistor R19 (Figure 1-33). Check resistance from pin 7 of J1 to ground; reading should be in excess of 100K ohms with fuse F3 removed.

Step 5 -800V Circuit Failure. Check fuse F2 (Figure 1-35); check voltage regulators VR1 through VR12; check capacitors C5 and C6 as well as resistors R10, R11 and R12. Check diodes CR5, CR6, CR7, and CR8; check resistance from pin 4 of J1 to ground; the reading should be in excess of 1 megohm.

Step 6 CRT Filament Voltage. Check continuity between pins 8 and 9 of T1. These pins should show in excess of 1 megohm to ground. A check between pin 8 of T1 and pin 4 of J1 should show continuity.

Step 7 Tube Filament Voltage. Check pins 12 and 13 of T1; these pins should show continuity and pin 12 of T1 should show continuity to pins 15, 14, and 13 of J1.

Step 8 AC Ripple Present on -150V Circuit.

NOTE

Ripple is normally caused by a filter component or diode failure. This condition can be checked with power on by connecting an ac vacuum tube voltmeter or oscilloscope between the dc source and ground. When the dc circuit containing the ripple has been isolated, the following steps should be taken.

CAUTION

Use a 1000v, 0.25 mfd capacitor in series with the probe when checking ripple on -800v circuit.

With power off test the OA2 voltage regulator tube V3 on a tube tester. Check diode CR9 for front-to-back ratio, 10 ohms to 10 megohms. Make the following ohmmeter tests:

L2 should read at least 200 ohms between its terminals.

C8 and C9 must read at least 100K ohms to ground after fuse F3 has been removed.

Check R22 for open or for changed resistance value.

Step 9 AC Ripple Present on -800V Circuit. With power on, the voltage regulator tubes VR1 - VR12 should light with a steady orange glow. If neon lamps are illuminated but flickering when power is on, remove power and discharge capacitors C5 and C6. Check the capacitors and check the power source for varying voltage. If lights do not light, remove power and discharge C5 and C6 by shorting pin 4 of J1 to ground, then make the following ohmmeter tests:

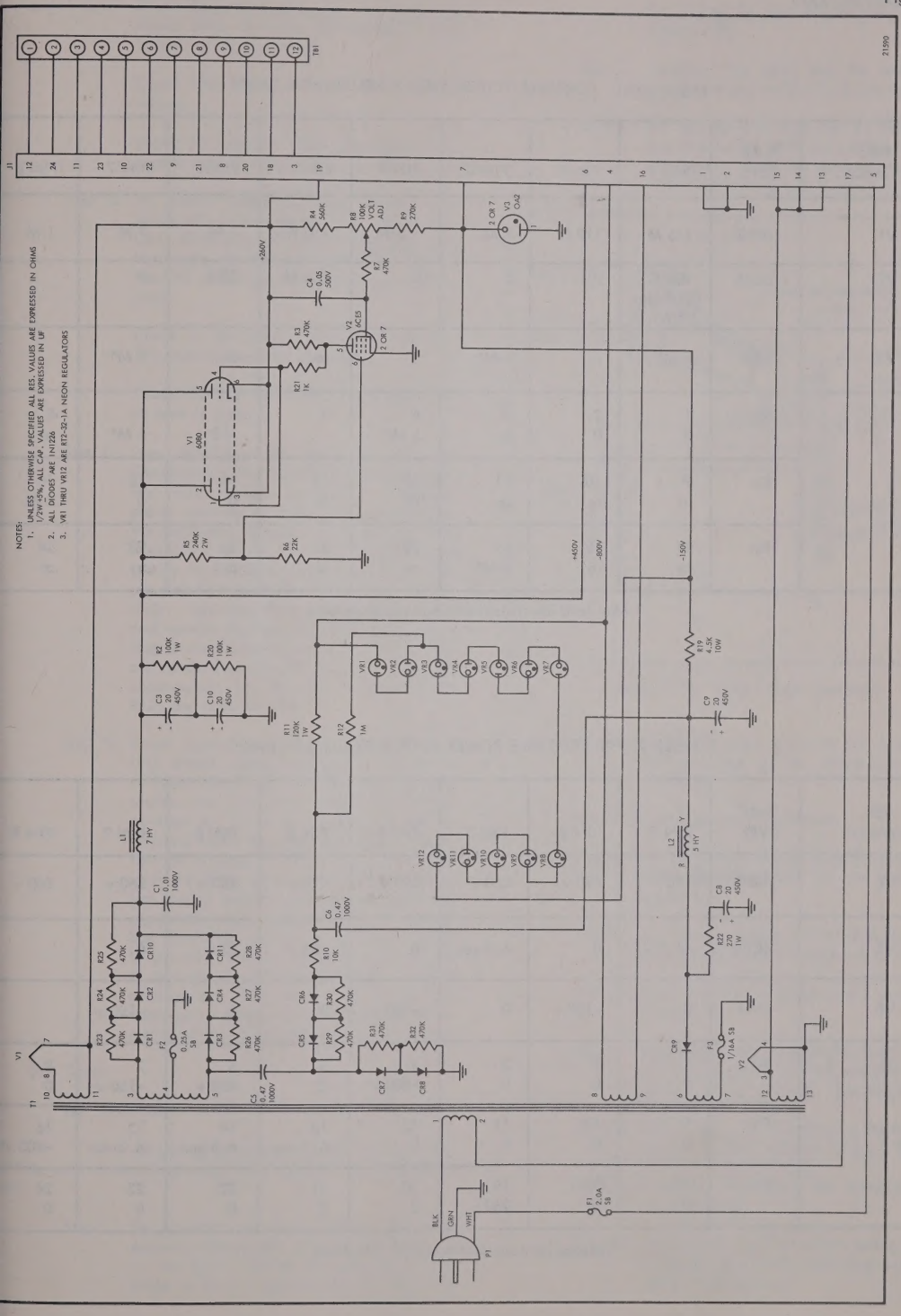


Figure 1-69. Portable Power Supply Model 14-104A - Schematic

TABLE XXIII. PORTABLE POWER SUPPLY RESISTANCE CHART

REF. SYMBOL	TUBE TYPE	PIN 1	PIN 2	PIN 3	PIN 4	PIN 5	PIN 6	PIN 7	PIN 8
V1	6080	1.5 M	110 K	1 M	1.5 M	110 K	1 M	1 M	1 M
V2	6CE5	900 K (R8 fully CCW)	0	0	0	1.5 M	20 K	0	
V3	OA2	4 M*	∞	4 M*	0	∞	∞	4 M*	
J1	Pin	1 0	2 0	3 ∞	4 5 M*	5	6 113*	7 5 M*	8 ∞
	Pin	9 ∞	10 ∞	11 ∞	12 00	13 0	14 0	15 0	16 5 M
	Pin	17 ∞	18 ∞	19 5 M*	20 ∞	21 ∞	22 ∞	23 ∞	24 ∞

* May read lower depending on Meter Polarity

TABLE XXIV. PORTABLE POWER SUPPLY VOLTAGE CHART

REF. SYMBOL	TUBE TYPE	PIN 1	PIN 2	PIN 3	PIN 4	PIN 5	PIN 6	PIN 7	PIN 8
V1	6080	190 v	420 v	260 v	190 v	420 v	260 v	260 v	260 v
V2	6CE5	-1.2 v	0	6.3 vac	0	185 v	33 v	0	
V3	OA2	0	-150 v	0	-150 v	0	0	-150 v	
J1	Pin	1 0	2 0	3 0	4 -800 v*	5 0	6 450 v	7 -150 v	8 0
	Pin	9 0	10 0	11 0	12 0	13 6.3 vac	14 6.3 vac	15 6.3 vac	16 -800 v*
	Pin	17 0	18 0	19 260 v	20 0	21 0	22 0	23 0	24 0

* Voltage between pins 4 and 16 = 6.3 vac

Check diodes CR5, CR6, CR7, and CR8; all should have the same front-to-back ratio, 10 ohms to 10 megohms.

Check R10, R11, and R12 for changing values.

Check C5 and C6. These capacitors should read at least one megohm to ground.

Step 10 AC Ripple Present on -450V Circuit. With power off, check diodes CR1, CR2, CR3, CR4, CR10 and CR11 for correct front-to-back ratio, 10 ohms to 10 megohms. Remove fuse F2 and make the following ohmmeter tests:

Check L1 for shorted turns; it should read 100 ohms between its terminals.

Check C3 and C10; they should read 120K or more to ground.

Step 11 Poor Regulation on 260V, Pin 19, J1. Remembering that the regulated voltage uses the -150v circuit source as a reference point, and the 450v circuit as a source for the regulated voltage, first check for -150v from pin 7 of J1 to ground. If this voltage proves to be correct and ripple-free, test pin 6 of J1 to ground for the proper voltage, 450v. Assuming these voltages are present and correct, the tube check recommended in Step 3 should be performed. If these tubes are conducting properly, check the following components: R3, R4, R5, R6, R7, R8, R9, R12, and capacitor C4.

Step 12 Proper Operation. As a final test for correct power supply operation, connect a variable autotransformer between the input source and the power supply. Voltages between pin 19 of J1 and ground should be checked while the autotransformer is varied through a range of 105 to 125 volts. This variance of the power source should result in less than 5 percent change in the 260-volt regulated output. In addition, a decade box should be connected from pin 19 of J1 to ground. The resistance should be varied so that the current changes from 0 to 125 milliamperes with less than 5 percent variance in output voltage regardless of the setting of the decade box or autotransformer.

(6) Coder

(a) Assembly

The following procedure details the method of setting up a coder, beginning with a completely disassembled unit.

Step 1 To assemble the motor attach the hinge assembly (hinge pin, hinge, and armature) to the heel. Adjust the position of the hinge to give a gap of 0.002 inch between the end of the heel and the armature. See Figure 1-70.

Step 2 Assemble the pawl and the pawl screw, securing with a 4-40 x 3/16 hex nut.

Step 3 Put the pawl overrun stop on the armature arm and secure with the pawl screw (pawl attached). Lock the pawl screw in place with another 4-40 x 3/16 hex nut.

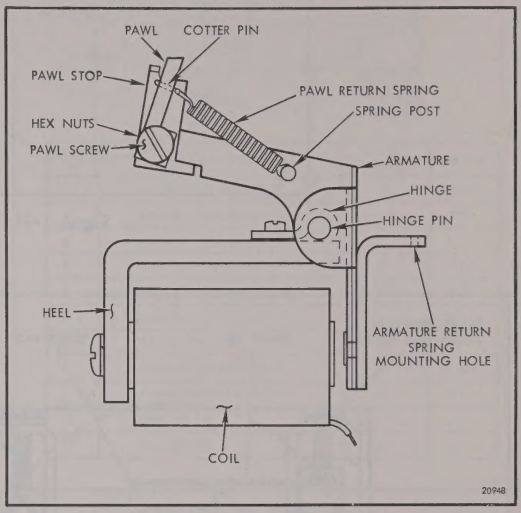


Figure 1-70. Coder Motor Assembly

Step 4 Mount the pawl spring on the cotter pin in the pawl and on the spring post on the armature.

Step 5 Install the coil in the heel.

Step 6 The coil in the heel is installed by mounting the indexing wheel on the hub. See Figure 1-71.

Step 7 Put the coding disc on the hub and secure it with the retaining disc and two screws.

Step 8 Lubricate the indexing wheel with a light machine oil.

Step 9 The coder is then assembled by first installing the centering nut in the frame and securing with a 12-24 hex nut. See Figure 1-72.

Step 10 Mount the motor assembly in the frame and loosely secure it with two 3-56 x 3/8 screws.

Step 11 Assemble and install the armature return spring adjuster.

Step 12 Connect the armature return spring from the armature plate to the mounting post on the adjusting mechanism.

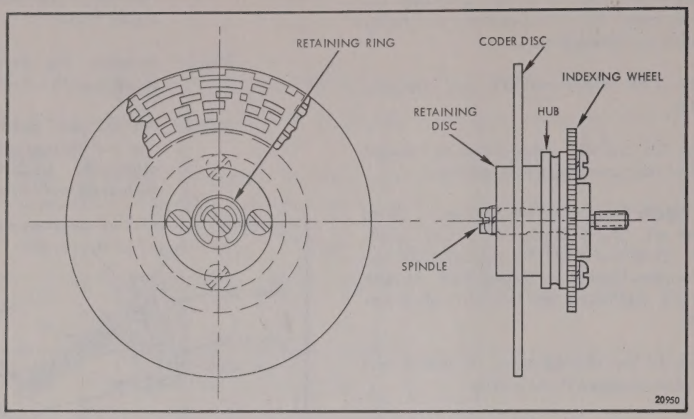


Figure 1-71. Coder Disc Assembly

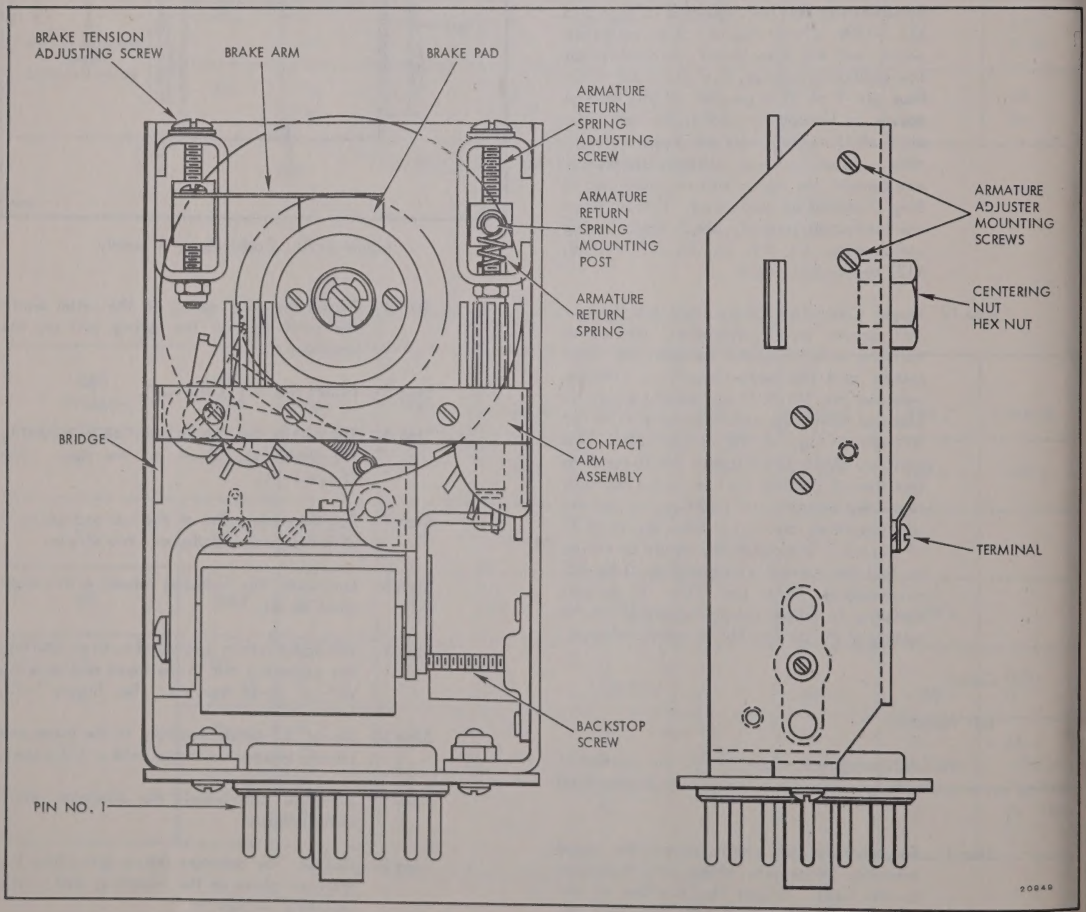


Figure 1-72. Coder Assembly

Step 13 Lubricate the pawl bearings and armature bearings with light machine oil.

Step 14 Position the coding disc assembly on the centering nut. Use a small screwdriver or similar device to hold the pawl out of the way of the indexing wheel.

Step 15 Mount the retaining ring on the spindle.

Step 16 Grease the spingle with a light grease such as Lubriplate and pass it through the hub into the centering nut.

Step 17 Assemble the brake arm assembly and lubricate the brake pad with a light machine oil.

Step 18 Mount the brake arm assembly on the frame so that the brake pad rides on the hub just above the indexing wheel.

Step 19 Adjust the brake arm tension so that when the armature is actuated (by hand) and released there is no anti-clockwise movement in the index wheel.

Step 20 Install the bridge and secure it with four 2-56 x 5/32 screws.

Step 21 Carefully place the contact arm assembly on the bridge so that the contact arms rest on the message disc. Secure it in place with the plate and three 2-56 x 5/16 screws. Before tightening the screws see that the contact arms are centered on their respective tracks on the disc.

Step 22 Wire the contact arms and coil to the connector as shown in Figure 1-73.

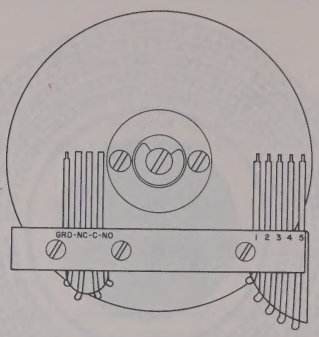
(b) Adjustments

Step 1 Insert a 0.005 inch feeler gauge between the armature and the coil. With the armature held against the feeler gauge, rotate the motor assembly around the armature pivot until the overrun stop bears against the back of the pawl, which must be fully engaged with the indexing wheel. Tighten the motor mounting screws in this position.

Step 2 Screw in the backstop screw until it just touches the armature. Release the armature and screw the backstop out until the pawl clicks back one tooth. While looking at the pawl through the hole in the chassis, screw out the backstop until the pawl is approximately one third up the side of the next tooth.

Step 3 Adjust the armature return spring to a tension of 150 grams.

Step 4 Recheck the brake arm adjustment. The brake arm tension should be adjusted so that there is no anti-clockwise motion of the indexing wheel when the armature is actuated.



PIN NO.	CONNECTION	COLOR CODE	LENGTH
1	CONTACT FINGER NO. 1	0	4-1/2
2	CONTACT FINGER NO. 2	1	3-3/4
3	CHANGE-OVER SWITCH (NO)	3	5
4	CONTACT FINGER NO. 3	94	3-1/2
5	CHANGE-OVER SWITCH (NC)	5	3
6	CONTACT FINGER NO. 4	6	3
7	CHASSIS GROUND	7	6
8	CONTACT FINGER NO. 5	8	2-3/4
9	CHANGE-OVER SWITCH (C)	9	4-1/2
10	COIL (586 D4)	4	2
11	COIL (586 D4)	2	2

20951

Figure 1-73. Coder Wiring

Step 5 Rotate the coding disc slightly so that the contact arms are centered on one of the character patterns. The contacts on both the left and right sides of the disc should be centered on their respective contact points. It may be necessary to loosen the screws holding the contact arms and reposition the contact arms slightly.

Step 6 Step the disc through each position, checking to be sure that each contact arm is properly centered on the pattern at each position.

Step 7 Using the Coder Adapter Cable, Model 14-105, thoroughly test the coder under working conditions. Note that the disc steps smoothly, with no jerking at high speeds.

Step 8 Complete the assembly of the coder by putting the cover on and installing the coder in the Transmitter.

(c) Universal Coder Disc

The universal coder disc is a 100 character message blank, on which any 98 character test transmission may be

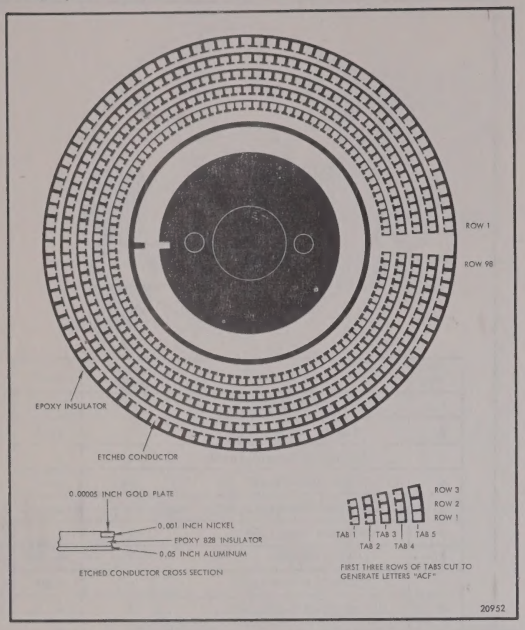


Figure 1-74. Message Disc

cut, including two letter shifts, Figure 1-74. The backing plate of the disc, which gives it structural strength, is covered with a layer of insulating material to isolate it electrically from the message area. A pattern of etched conductors is inlaid into the insulating material; it is this conducting area that generates the message through the contact arms of the coder. The solid radial strip at the 3 o'clock position on the disc is the two letter shift characters. The inner broad, solid ring with the offset area at the 9 o'clock position is a switch which stops the operation of the coder after each cycle. (However, should the exterior switch remain closed the coder will continue to operate.)

The remaining portion of the disc is the message area. This area is composed of five rings of narrow conductors; each conducting ring is connected to 98 small square tabs through narrow connecting strips. These tabs are arranged in radial rows. Each of these radial rows of tabs forms one five-element character; each tab in the row forms one element of the character. As shipped from the factory all the tabs are connected to grounding rings. A coder contact arm passing over a grounded tab generates a mark element.

d. Calibration

(1) Calibration Schedule

Intervals between calibration can vary widely depending on use and environment. Equipment used only at intervals and housed in well air-conditioned buildings should operate for a year without losing accuracy. Equipment used constantly and in ordinary surroundings should be recalibrated every 30 days. If certain tubes specified in (c), (d) and (e) below are replaced, recalibration is required immediately.

(2) Equipment Required

Nomenclature	Electronic Counter	Signal Generator	Oscilloscope	DC Voltmeter
Part Number or Model	Hewlett-Packard 522B or equal	Hewlett-Packard 200CD or equal	Tektronix 315 or equal	Triplett 630A or equal
Application	Frequency Measurement	Test signal generation	Voltage Measurement	Voltage Measurement
Range	40-320 cps	110 cps	10 volts p-p	260 vdc
Accuracy	±0.6%	±1%	±5%	±1-1/2% required ±1% preferred

(3) Transmitter Calibration

Perform (a) and (b) below every 30 days. If a tube in the oscillator circuit is replaced at any time, perform (a) immediately. If V16 is replaced, perform (b) immediately.

(a) Speed Ranges

The following procedure details the method of calibrating the Transmitter for the 30 and 50 baud speed ranges. The other ranges are calibrated in the same manner as the 50 baud range. The calibration controls for each range are as follows: 30/CAL 1 and 30/CAL 2 are for the 30 baud range; 50/CAL 1 and 50/CAL 2 for the 50 baud range, 70/CAL 1 and 70/CAL 2 for the 70 baud range; 90/CAL 1 and 90/CAL 2 for the 90 baud range; 110/CAL 1 and 110/CAL 2 for the 110 baud range; 130/CAL 1 and 130/CAL 2 for the 130 baud range; and 150/CAL 1 and 150/CAL 2 for the 150 baud range (see Figure 1-39 for the location of these controls).

The frequency measured for each setting of the RANGE switch should be twice the switch setting (VERNIER at 0). For example, with the RANGE switch set to 50 the frequency should be 100 cps. Setting the VERNIER control to +10 should increase the frequency by 20 cps, setting it to -10 should decrease the frequency 20 cps.

When the RANGE switch is changed from one position to another, the diameter of the CRT trace should not vary.

NOTE

The 30 baud speed range must be calibrated first as the 30/CAL 1 and 30/CAL 2 controls affect the calibration of all the other ranges.

Step 1 Turn the Transmitter on and allow a 10-minute warm-up interval.

Step 2 Connect frequency measuring device across SPEED indicator I2.

Step 3 Set RANGE switch to 30.

Step 4 Set VERNIER control to 0.

Step 5 Set DISPLAY switch to NORMAL OUTPUT position.

Step 6 Using the COARSE AMP control and the AMPLITUDE control, adjust the circle until it just touches the inner edge of the scale markings.

Step 7 Adjust 30/CAL 1 and 30/CAL 2 alternately in small steps until a reading of 60 cps is obtained on the frequency measuring device. Repeat Step 6 before taking final reading.

Step 8 Set the VERNIER control to -10. The frequency should be 40 cps, plus or minus one.

Step 9 Set the VERNIER control to +10. The frequency should be 80 cps, plus or minus one.

Step 10 If the frequencies measured in Steps 8 and 9 are not within the specified tolerances, it will be necessary to return the VERNIER control to 0 and readjust 30/CAL 1 and 30/CAL 2. Turn the 30/CAL 1 control a small amount in either direction. Adjust 30/CAL 2 until the frequency again reads 60 cps.

Step 11 Repeat Steps 8 and 9. If the frequency observed is closer to the correct frequency continue as in Step 10 until the correct tolerances are obtained. If the frequency is further out of tolerance after Step 10, adjust 30/CAL 1 in the opposite direction and readjust 30/CAL 2 to obtain 60 cps.

Step 12 Set the RANGE switch to the 50 baud range and the VERNIER control to 0.

Step 13 Alternately adjust 50/CAL 1 and 50/CAL 2 for a 100 cps reading on the frequency measuring device. The diameter of the circle should remain the same as it was in the 30 baud position, without readjustment of the amplitude controls. Should the circle not be the same size, perform Step 14.

NOTE

The following step is applicable only if the diameter of the CRT trace varies from that of the preceding baud range.

Step 14 Adjust 50/CAL 1 for proper trace diameter; adjust 50/CAL 2 to obtain a frequency of 100 cps. It may be necessary to repeat this operation several times to obtain the best performance.

Continue as above, repeating Steps 12 and 13 for each setting of the RANGE switch. After calibrating the Transmitter for the 150 baud range, rotate the RANGE switch through each of its positions with the VERNIER control set to +10, -10, and 0. The diameter of the CRT trace should not vary with varying settings of the RANGE and VERNIER controls.

(b) INPUT BAL, R301

This control is located on the "D" door on the right side of the unit. To adjust this control, turn the Transmitter on and set the controls listed below to the indicated positions.

RANGE switch - Set to 110.
VERNIER control - Set to 0.
DISPLAY switch - Set to INPUT.
INPUT SIGNAL - Set to POLAR +M

Next, connect a 10-volt peak-to-peak, 110 cps sine wave to the Input 2 and Input Common terminals. Adjust the VERNIER control until the dot on the circular trace is stationary. If the INPUT BAL control is properly adjusted there will be only one dot. If two dots are present, adjust the INPUT BAL control until the two dots coincide.

(4) Receiver Calibration

The Receiver should be recalibrated every 30 days, following the procedure below. The Receiver will have to be recalibrated regardless of schedule if a tube in the oscillator circuit is replaced.

(a) Receiver

Step 1 Turn the Receiver on, and allow a 10-minute warm-up interval.

Step 2 Connect an electronic counter or other accurate frequency measuring device with a range of 20 to 160 cps to the rear connection of the SPEED indicator I2.

Step 3 With an accurate voltmeter measure the +260 vdc at the junction of R572 and R573. Reset the voltage control on power supply, if necessary.

Step 4 Set RANGE switch to 30.

Step 5 Set VERNIER control to 0.

Step 6 Set TIME BASE switch to CIRCULAR.

Step 7 Adjust AMPLITUDE control until circle just touches the inner edge of the scale markings.

Step 8 Adjust 30/CAL 1 and 30/CAL 2 alternately in small steps until a reading of 30 cps is obtained on the frequency measuring device. Repeat Step 7 before taking final reading.

Step 9 Check the amplitude and linearity of the circular trace. The circle should just touch the inner edge of the scale markings. Both controls should be set near the center of their ranges.

Step 10 Set the VERNIER control to -10; the frequency should be 20 cps, plus or minus one half.

Step 11 Set the VERNIER control to +10; the frequency should be 40 cps, plus or minus one half.

Step 12 If the frequencies measured in Steps 10 and 11 are not within the specified tolerances it will be necessary to set the VERNIER control back to 0 and readjust 30/CAL 1 and 30/CAL 2. Turn the 30/CAL 1 control a small amount in either direction and then adjust 30/CAL 2 until the frequency again reads 30 cps.

Step 13 Repeat Steps 10 and 11, noting whether an improvement was made or if the frequency is further out of tolerance. If it is further out of tolerance than it originally was, repeat Step 12 except start by adjusting 30/CAL 1 in the opposite direction.

Step 14 Set the RANGE switch to 50 and the VERNIER control to 0.

Step 15 Alternately adjust 50/CAL 1 and 50/CAL 2 controls for a 50 cps reading on the frequency measuring device. The diameter of the circle should remain the same as it was in the 30 baud position without readjusting the amplitude controls.

Step 16 Set the RANGE switch to 70.

Step 17 Alternately adjust the 70/CAL 1 and 70/CAL 2 controls for a 70 cps reading on the frequency measuring device. The diameter of the circle should remain the same as it was in the 30 baud position without readjusting the amplitude controls.

Step 18 Set the RANGE switch to 90.

Step 19 Alternately adjust the 90/CAL 1 and 90/CAL 2 controls for a 90 cps reading on the frequency measuring device. The diameter of the circle should remain the same as in the previous steps.

Step 20 Set the RANGE switch to 110.

Step 21 Alternately adjust to 110/CAL 1 and 110/CAL 2 controls for a 110 cps reading on the frequency measuring device. The diameter of the circle should remain the same as in the previous steps.

Step 22 Set the RANGE switch to 130.

Step 23 Alternately adjust 130/CAL 1 and 130/CAL 2 controls for a 130 cps reading on the frequency measuring device. The diameter of the circle should remain the same as in the previous steps.

Step 24 Set the RANGE switch to 150.

Step 25 Alternately adjust the 150/CAL 1 and 150/CAL 2 controls for a 150 cps reading on the frequency measuring device. The diameter of the circle should remain the same as in the previous steps.

Step 26 Rotate the RANGE switch through each position. For each RANGE switch setting the circle should remain the same size.

Step 27 For each RANGE switch setting set the VERNIER control to -10; the frequency measuring device should read the range setting minus 10 cps. The frequency must be within plus or minus one half cycle per second.

Step 28 For each RANGE switch setting set the VERNIER control to +10; the frequency measuring device should read the range setting plus 10 cps. The frequency must be within plus or minus one half cycle per second.

(b) Oscillator Start and Hold Controls Adjustment

Step 1 Turn on the Receiver, set it for spiral-trace operation, and allow a 10-minute warm-up interval.

Step 2 With the RANGE switch at 50 bauds and the VERNIER at +10 bauds apply a 60 cps signal to LINE 1 input. (6.3v filament transformer will suffice.)

Step 3 In each successive position of the UNIT CODE switch, (beginning with position 4 and proceeding clockwise), the spiral trace should increase one full turn; the spirals should remain equidistant from each other; the start of the trace should begin at the zero mark on the scale.

Step 4 If the spiral does not meet these requirements the following steps must be taken - carefully.

Step 4a When trace does not start at "0" (all other bright dots form a vertical line radial to "0"):

(1) Adjust OSC START control (R434) in small increments and observe trace reaction closely. If first movement of the OSC START control improves the condition, readjust the OSC HOLD control and continue adjustment of the OSC START control in the same direction. Readjust the OSC HOLD control after each OSC START resetting.

NOTE

OSC START and OSC HOLD controls are interactive and each change in one must be compensated by readjustment of the other.

(2) If the first small OSC START adjustment causes a more aggravated condition, the OSC START direction of rotation must

be reversed and the same careful procedure followed. A 5-degree rotation of either of these controls is considered a large step.

Step 4b In some cases, improper adjustment of the OSC HOLD control increases the spacing between spirals until the start dot is "off scale" or reduces the spacing until the trace starts within the scale. If the spacing between spiral loops is not equidistant the OSC HOLD control must be adjusted in the same manner as the OSC START control.

NOTE

In general, the OSC START control positions the start element bright spot along the periphery of the circle while the OSC HOLD control adjusts the spacing between the turns of the spiral. However, note that in Step 4a OSC START is the preset control and OSC HOLD control acts as the compensating control; in 4b the OSC HOLD control is the preset control, while the OSC START acts as the compensating control.

Step 5 Rotate the RANGE switch through each position. The spiral should open as in Step 3. If not, it may be necessary to readjust, slightly, the OSC START and OSC HOLD controls.

(5) Tel-A-Scan Calibration

If V2 is changed, the Vertical Amp Bias and C719 ettings must be recalibrated. If V10 is changed, the sweep anges must be recalibrated. If V1 is changed, the Calibrator ill require recalibration. If no tubes are changed, the ollowing procedures should be followed every 30 days.

(a) Vertical DC Balance Adjustment

Step 1 Turn the Vertical Gain Control to minimum.

Step 2 Set the ATTENUATOR switch, S752, to GRD.

Step 3 Adjust the STABILITY control, R751, until a linear sweep appears on the CR tube.

Step 4 Rotate the VERT GAIN control, R716, in both directions while simultaneously adjusting the DC BALANCE screwdriver adjustment, R719, until there is no further vertical movement of the sweep trace.

(b) Vertical Amplifier Bias Setting

Step 1 Set 1st Vertical Amp Bias Control to the center of its range.

Step 2 Make sure the Vertical Position control will move the sweep off the top and off the bottom of the screen. Keep the Vertical Amp Bias control as near the center of its range as possible while retaining sufficient range on positioning.

(c) C719 Adjustment

Step 1 Connect a 1 kc square-wave generator to INPUT 1. Set INPUT SEL switch, S750, to INPUT 1 and ATTENUATOR switch, S752, to X1. Set output of signal generator to obtain a one inch deflection on the CRT with the VERT GAIN control at maximum clockwise rotation.

Step 2 Adjust C719 (mounted on the Vertical Amplifier Chassis) for the most perfect square wave.

(d) Vertical Attenuator

NOTE

C719 adjustment (Paragraph 5.5c) must be completed before adjusting the Attenuator.

(1) INPUT 1

Step 1 Connect a 1 kc square-wave generator to INPUT 1. Set INPUT SEL switch, S750, to INPUT 1 and ATTENUATOR switch, S752, to X10. Set output of signal generator to obtain a one inch deflection.

Step 2 Adjust C703 (mounted on S752 rear, lower capacitor, right side) for the most perfect square wave.

Step 3 Set ATTENUATOR switch to X100 and increase output of square-wave generator until approximately one inch deflection is observed.

Step 4 Adjust C705 (mounted on S752 rear, middle capacitor, right side) until the most perfect square wave is obtained.

Step 5 Set ATTENUATOR switch to X1000 and increase output of square-wave generator until approximately one inch deflection is observed.

Step 6 Adjust C707 (mounted on S752 rear, top capacitor, right side) until the most perfect square wave is obtained.

(2) INPUT 2

Step 1 Connect the 1 kc square-wave generator to INPUT 2. Set INPUT SEL switch S750 to INPUT 2 and ATTENUATOR switch S752 to X10. Set output of generator to obtain a one inch deflection.

Step 2 Adjust C709 (mounted on S752, rear, top capacitor, left side) for the most perfect square wave.

Step 3 Set ATTENUATOR switch to X100 and increase output of square-wave generator until approximately one inch deflection is observed.

Step 4 Adjust C711 (mounted on S752, rear, middle capacitor, left side) until the most perfect square wave is observed.

Step 5 Set ATTENUATOR switch to X1000. Increase the output of the square-wave generator until a one inch deflection is observed.

Step 6 Adjust C713 (mounted on S752, rear, lower capacitor, left side) until the most perfect square wave is obtained.

(e) Setting the Calibrator

Step 1 Turn VERT GAIN control R716 to its extreme CW position and set ATTENUATOR switch to GRD.

Step 2 Adjust STABILITY control until sweep is observed.

Step 3 Center trace on CRT screen by adjusting the VERT POS control.

Step 4 Adjust the DC BALANCE as outlined in Paragraph (a) above.

Step 5 Turn CALIB control R815 to its mid-position, so that the calibrate line on the CRT coincides with the normal sweep trace.

Step 6 The CALIB control should now read zero. If it does not, loosen the two set screws in the CALIB control knob, rotate knob until pointer is on zero, and tighten set screws.

Step 7 Connect an oscilloscope to pin 8, V1. Adjust CAL AMP (R805), until the top of the pulse displayed on the oscilloscope coincides with the dc level present at pin 8, V1.

Step 8 Connect a square-wave generator to INPUT 1. Set generator for a +1.0 volt peak signal. Adjust the STABILITY control until a square wave is observed on the Tel-A-Scan CRT. Set the ATTENUATOR switch to X1 and adjust the gain to obtain a one inch deflection.

Step 9 Adjust the CALIB control to +1.0 and adjust the CAL SET control so that the calibrate line coincides with the top of the square wave. Rotate the VERT GAIN control and insure that the calibrate line tracks with the waveform.

Step 10 Adjust output of the generator to 0.5 volt peak. Adjust the GAIN control to obtain a one inch deflection. Set the CALIB control to +0.5 so that the calibrate line coincides with the top of the square wave, $\pm$0.1 volt.

Step 11 Set the output of the generator to +0.2 volt. Set GAIN control to obtain a one inch deflection. Set the CALIB controls to +0.2 and see that the calibrate line coincides with the top of the square wave, $\pm$0.1 volt.

Step 12 Set the generator output to -1.0 volt peak. Set GAIN control to obtain one inch deflection. Center pattern on CRT. Set the CALIB control to -1.0 and see that the calibrate line tracks with the signal waveform.

Step 13 Set generator output to -0.5 volt. Set VERT GAIN control to obtain a one inch deflection. Set CALIB control to -0.5 and see that the calibrate line coincides with bottom of square wave, $\pm$0.1 volt.

Step 14 Set generator output to -0.2 volt peak. Set VERT GAIN control to obtain a one inch deflection. Set CALIB control to -0.2 and see that the calibrate line coincides with the bottom of the square wave, $\pm$0.1 volt.

(f) Sweep Calibration

Step 1 Set sweep RANGE switch, S755, to the 1-to-3 millisecond range; set VERNIER control R760 to 1. Feed an accurate 10 kc sine wave to INPUT 1 from the signal generator.

Step 2 Adjust STABILITY and TRIGGER controls for stable sweep. Adjust SWEEP CAL 1 potentiometer for 10 cycles.

Step 3 Set signal generator output to 3333 cps and turn VERNIER control to position 3.

Step 4 Adjust SWEEP CAL 2 potentiometer for 10 cycles as observed on CRT screen.

Step 5 Repeat all previous steps in this paragraph. (It may be necessary to readjust SWEEP CAL 1 and SWEEP CAL 2 alternately.)

Step 6 Set RANGE switch to the 100-to-300 microseconds position. Set VERNIER control to 1.

Step 7 Adjust the signal generator to 100 kc and adjust STABILITY and TRIGGER controls for stable sweep.

Step 8 Adjust C729 (mounted on rear of RANGE switch S755) for 10 cps as observed on the CRT screen.

(6) Rack Mount Power Supply Calibration

To place the TDMS unit in operation, check the 260-volt supply at J10, pin 19; if necessary, adjust the +260 VOLT ADJ control, R14, for proper voltage (260 vdc + 1 percent). Check the -150 volt supply at J10, pin 7 and adjust +150 VOLT ADJ control R38 for proper voltage (-150 vdc $\pm$ 1 percent).

(7) Portable Power Supply Calibration

Place the TDMS unit in operation. Check the +260v supply at pin 3 of V1; if necessary, adjust VOLT ADJ control R8 for proper voltage.

SECTION II
PARTS BREAKDOWN

INTRODUCTION

The mailing address of all manufacturers referenced in this section are listed on page 2-2.

Where Federal Stock Numbers have been assigned to parts appearing in this parts breakdown, those Federal Stock Numbers are listed separately beginning on page 2-140.

MANUFACTURERS NAMES AND ADDRESSES

Aerovox Corporation
740 Belleville Ave.
New Bedford, Mass.

Allen Bradley Company
202 W. Greenfield Ave.
Milwaukee 4, Wisconsin

Almco Steel Product Corp.
Wabash at Nickel Plate R.R.
Bluffton, Indiana

Amperite Company, Inc.
565 Broadway
New York 12, N. Y.

Amphenol Connector Division
Amphenol - Borg
Electronics Corporation
1830 S. 54th Avenue
Chicago 50, Illinois

Arrow Hart and Hegeman
Electric Company
103 Hawthorne Street
Hartford 6, Connecticut

Atlantic India Rubber
Works, Inc.
571 W. Polk Street
Chicago 7, Illinois

Automatic Electric Company
Northlake, Illinois

Belden Mfg. Co.
415 S. Kilpatrick
Chicago 44, Illinois

Carling Electric Inc.
495 New Park Avenue
Hartford, Connecticut

CBS - Hytron Division
Columbia Broadcasting System
Incorporated
100 Endicott Street
Danvers, Massachusetts

Centralab, Div.,
Globe Union, Inc.
974 E. Keefe Avenue
Milwaukee 1, Wisconsin

Chicago Telephone Supply
1142 West Beardsley Ave.
Elkhart, Indiana

Cinch Mfg. Corporation
1028 S. Homan
Chicago, Illinois

Clarostat Mfg. Co., Inc.
East Washington Street
Denver, N. H.

Cornell-Dubilier Elec. Corp.
900 Hamilton Blvd.
S. Plainfield, N. J.

Dakota Engineering Inc.
4315 Sepulveda Blvd.
Culver City, California

Dale Products, Inc.
Plant Street
Columbus, Nebraska

Drake Mfg. Company
4616 N. Olcott Ave.
Chicago 31, Illinois

Eby, Hugh H. Company
4701 Germantown Ave.
Philadelphia 44, Pa.

E. F. Johnson Company
299 - 10th Avenue
Waseca, Minnesota

Elastic Stop Nut Corp.
of America
1027 Newark Avenue
Elizabeth, N. J.

Erie Resistor Corporation
645 W. 12th Street
Erie, Pennsylvania

Federal Products Corporation
1188 Eddy Street
Providence, R. I.

Garde Mfg. Company
590 Eddy Street
Providence, R. I.

General Cement Company
Div. of Textron, Inc.
400 S. Wyman Street
Rockford, Illinois

General Electric Company
Power Tube Dept.
777 - 14th St. N. W.
Washington 5, D. C.

General Products Co., Inc.
Plant Street
Central Falls, R. I.

General Transistor Corp.
91 - 27 138th Place
Jamaica 35, N. Y.

Good-All Electric Mfg. Co.
P. O. Box 119
Ogallala, Nebraska

Holub Industries, Inc.
416 DeKalb Avenue
Sycamore, Illinois

Illinois Condenser Corp.
1618 N. Throop
Chicago 22, Illinois

Illinois Conductor Corp.
1618 N. Throop
Chicago 22, Illinois

International Rectifier Corp.
233 Kansas
El Segundo, California

Kulka Elec. Mfg. Co., Inc.
639 S. Fulton Street
Mt. Vernon, N. Y.

Kurz - Kash Inc.
1415 S. Broadway
Dayton 1, Ohio

Littelfuse, Inc.
1865 Miner
Des Plaines, Illinois

Mallory & Co., Inc. P.R.
44 S. Gray Street
Indianapolis 6, Indiana

Micro-Switch Division
Minneapolis-Honeywell
Reg. Co.
Chicago & Spring Sts.
Freeport, Illinois

Jas. Millen Mfg. Co., Inc.
150 Exchange
Malden, Massachusetts

J. W. Miller Co.
5917 S. Main St.
Los Angeles, California

Monadnock - Mills
1977 First Avenue
San Leandro, California

Ohmit Mfg. Co.
3685 Howard
Skokie, Illinois

Parker Seal Co.
17325 Euclid Avenue
Cleveland 12, Ohio

Plastic Capacitor, Inc.
2620 N. Clybourn Ave.
Chicago 14, Illinois

Radio Materials Company
4242 W. Bryn Maws Ave.
Chicago 46, Illinois

Radio Receptor Co., Inc.
240 Wythe Avenue
Brooklyn 11, N. Y.

Radiation Incorporated
Melbourne, Florida

Raytheon Company
100 Roester Rd.
Glenn Burmee, Md.

RCA
744 Broad Street
Newark 2, N. J.

Remler Company
2101 Bryant Street
San Francisco, Calif.

Signalite
41 Neptune Hwy.
Neptune, N. J.

Sprague Electric Co.
Marshall Street
N. Adams, Mass.

Switchcraft, Inc.
5565 N. Elston Ave.
Chicago 30, Illinois

Sylvania Electric Products, Inc.
1740 Broadway
New York 19, N. Y.

Times Facsimile Corporation
540 W. 58th Street
New York 19, N. Y.

U. S. Engineering
13536 Saticoz Street
Van Nuys, California

Waldes Kohinoor, Inc.
47 - 16 Austel Place
Long Island City 1, N. Y.

Wuerth Products Corporation
1949 Moffett Street
Hollywood, Florida

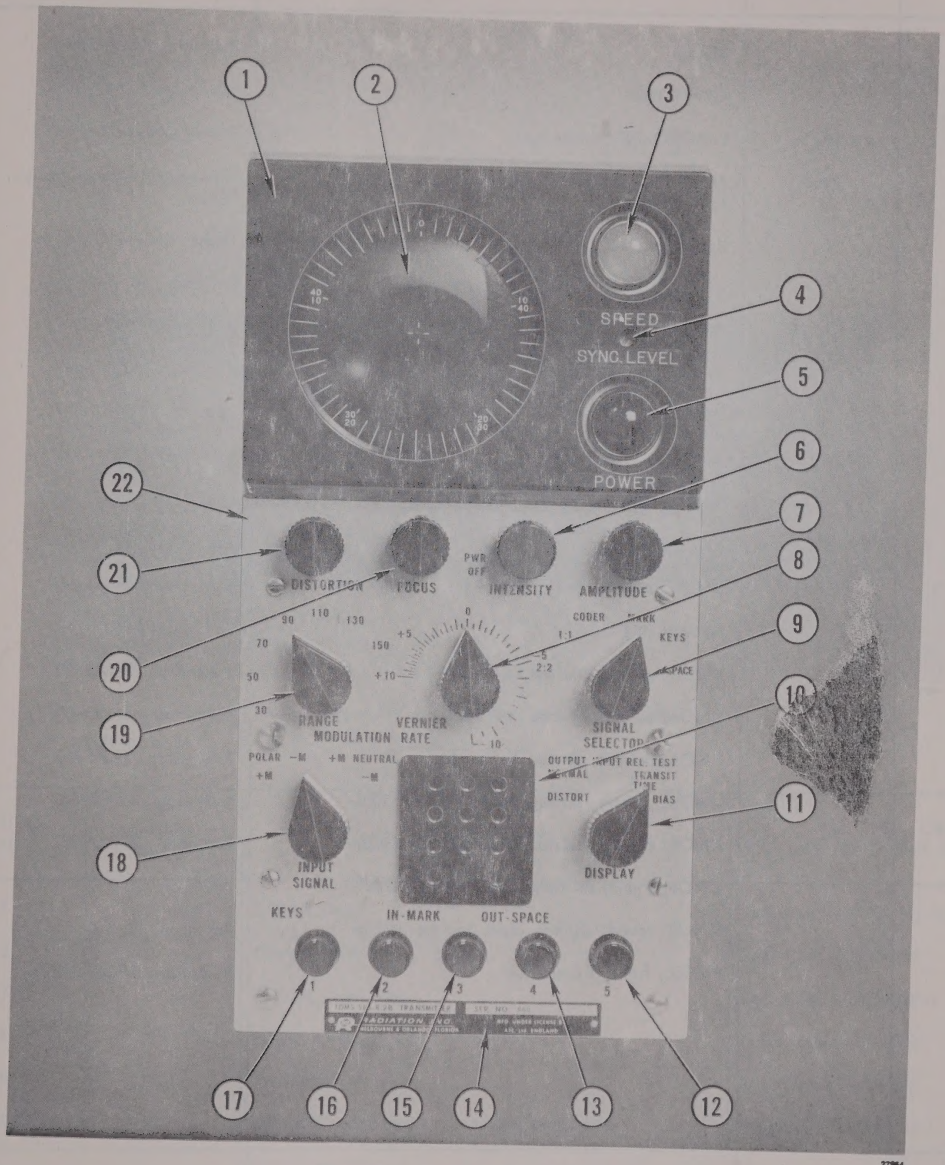


Figure 2-1. Transmitter Front Panel

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1		BEZEL:	Radiation, 9037-380-1
2		GRATICULE:	Radiation, C9037-310
3	I2	LAMPHOLDER, white lens:	Drake, 660-1-1L
4	R163	RESISTOR, variable, composition: 1 meg, 10%, slotted shaft:	Chicago Telephone Supply, FR6646
5	I1	LAMPHOLDER, red lens:	Drake, 260-1-1L
6		KNOB, round, skirted, red cap (for S101):	Raytheon, 70-2-2
7		KNOB, round, skirted, black cap (for R129):	Raytheon, 70-2-2
8		KNOB, pointer, skirted, modified (for R153):	Radiation, A9037-347
9		KNOB, pointer, skirted, modified (for S104):	Radiation, A9037-347
10	J102	SOCKET, relay:	Radiation, B9037-303
11		KNOB, pointer, skirted, modified (for S105):	Radiation, A9037-347
12		KNOB, pushbutton (for S119):	Kurz-Kash, S-345-60
13		KNOB, pushbutton (for S118):	Kurz-Kash, S-345-60
14		NAMEPLATE:	Radiation, B9037-710-1
15		KNOB, pointer, skirted (for S117):	Kurz-Kash, S-345-60
16		KNOB, pointer, skirted (for S116):	Kurz-Kash, S-345-60
17		KNOB, pointer, skirted (for S115):	Kurz-Kash, S-345-60
18		KNOB, pointer, skirted, modified (for S103):	Radiation, A9037-347
19		KNOB, pointer, skirted, modified (for S102):	Radiation, A9037-347
20		KNOB, round, skirted, black cap (for R288):	Raytheon, 70-2-2
21		KNOB, round, skirted, black cap (for R213):	Raytheon, 70-2-2
22		PANEL, front, Transmitter:	Radiation, D9037-122-1

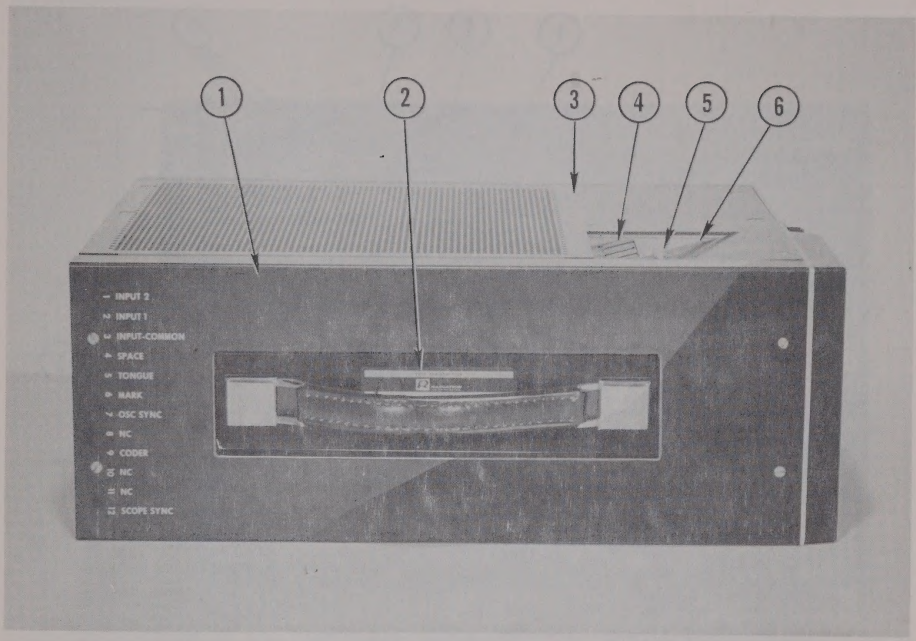


Figure 2-2. Transmitter Top and Right Side

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1		COVER, top:	Radiation, D9037-341-1
2		NAMEPLATE:	Radiation, C9037-797
3		COVER, right side:	Radiation, D9037-329-1
4		POST, binding: red with nut (4)	E.F. Johnson, 111-102
5	S111	SWITCH, rotary:	Radiation, C9037-305
6		BRACKET, binding post, recessed, right side:	Radiation, C9037-323-1

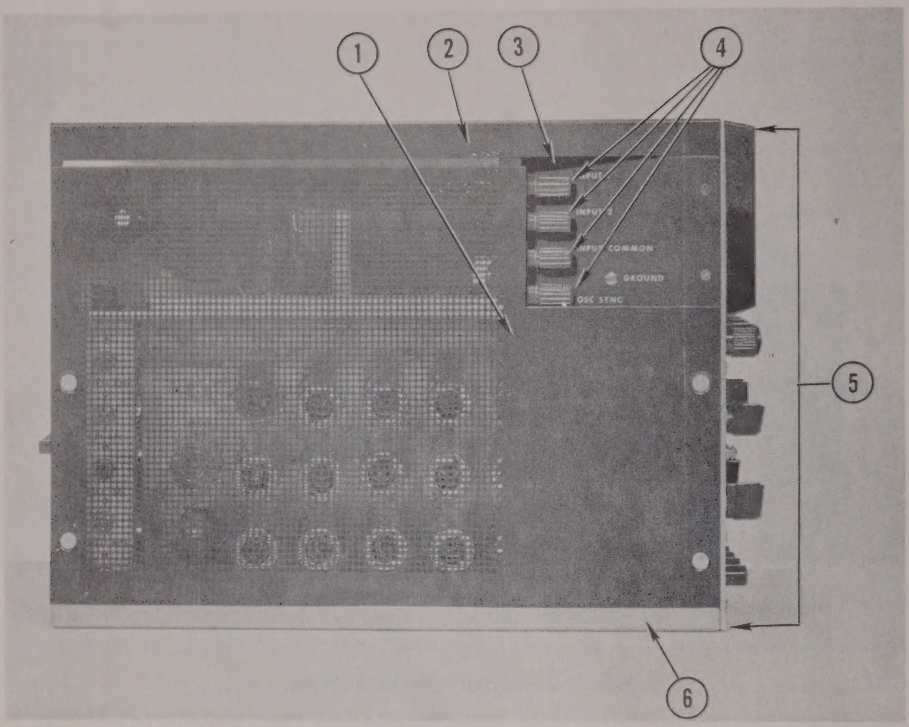


Figure 2-3. Transmitter Left Side

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1		COVER, left side:	Radiation, D9037-329-2
2		COVER, top:	Radiation, D9037-341-1
3		BRACKET, binding post, recessed, left side:	Radiation, C9037-326-2
4		POST, binding: black with nut (4)	E.F. Johnson, 111-103
5		CONTROLS, front panel:	See Figure 2-2
6		COVER, bottom:	Radiation, D9037-1310-2

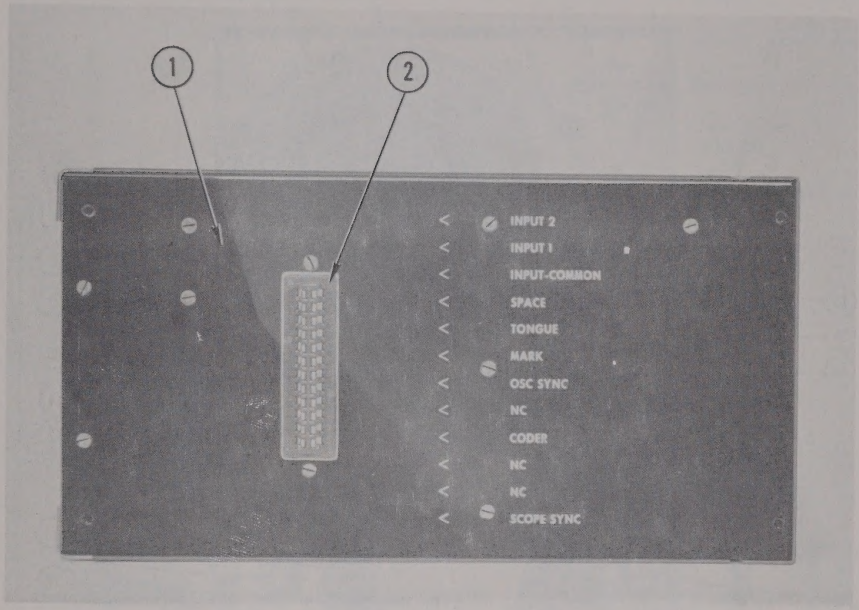


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Figure 2-4. Transmitter Rear View

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1		REAR COVER:	Radiation D9037-336-1
2	P101	CONNECTOR:	Amphenol, 26-4100-24P

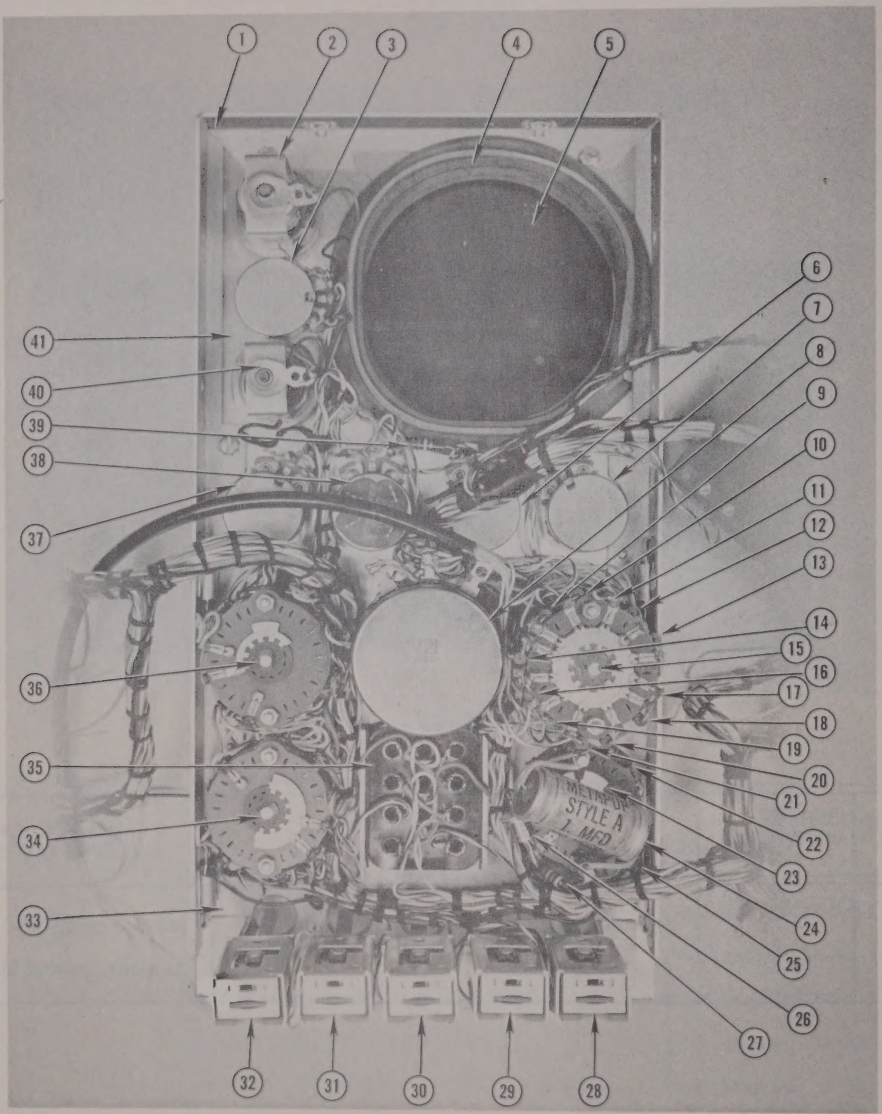

Figure 2-5. Transmitter Front Panel Interior

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1		PANEL LIP, front:	Radiation, D9037-322-2
2	12	LAMPHOLDER, white lens: LAMP, glow:	Drake, 660-1-1L General Electric, NE2I
3	R163	RESISTOR, variable, composition: I meg, ± 10%, slotted shaft	Chicago Telephone Supply, FR6646
4		EXTRUSION:	Atlantic India Rubber, X3606
5		GRATICULE:	Radiation, C9037-3I0
6	R288	RESISTOR, variable, composition: 250k, ±10%, 3/4" shaft	Chicago Telephone Supply, HQ3634
7	R213	RESISTOR, variable, composition: 1k, ± 10%, 3/4" shaft	Chicago Telephone Supply, FR665I
8	R153	RESISTOR, variable, dual, wire wound: 30k, ± 1%	Clarostat, 58
9	R336	RESISTOR, fixed, composition: 1/2w, ± 5%,220k	RC20GF224J
10	R337	RESISTOR, fixed, composition: 1/2w, ± 5%, 300k	RC20GF304J
11	R338	RESISTOR, fixed, composition: 1/2w, ± 5%, 390k	RC20GF394J
12	R339	RESISTOR, fixed, composition: 1/2w, ± 5%,560k	RC20GF564J
13	R345	RESISTOR, fixed, composition: 1/2w, ±5%, 820k	RC20GF824J
14	R347	RESISTOR, fixed, composition: 1/2w, ±5%, 1.5m	RC20GFI55J
15	S102	SWITCH, rotary:	Radiation, C9037-112
16	R344	RESISTOR, fixed, composition: 1/2w,± 5%, 820k	RC20GF824J
17	R346	RESISTOR, fixed, composition: 1/2w, ± 5%, 1.5m	RC20GF155J
18	R340	RESISTOR, fixed, composition: 1/2w, ± 5%, 220k	RC20GF224J
19	R343	RESISTOR, fixed, composition: 1/2w, ± 5%, 560k	RC20GF564J
20	R341	RESISTOR, fixed, composition: 1/2w, ± 5%, 300k	RC20GF304J
21	R342	RESISTOR, fixed, composition: 1/2w, ± 5%, 390k	RC20GF394J
22	RI07	RESISTOR, fixed, composition: Im, 1/2w, ± 5%	RC20GFI05J
23	S103	SWITCH, rotary:	Radiation, C9037-307
24	C101	CAPACITOR, fixed, paper: I mf, ± 20%, 200v	Cornell-Dubilier, MTM-2-W1
25	R106	RESISTOR, fixed, composition: Im, 1/2w, ±5%	RC20GF105J
26	CR101	DIODE:	Radio Receptor, PT5
27	R105	RESISTOR, fixed, composition: 47k, 1/2w, ±5%	RC20GF473J
28	S119	SWITCH, pushbutton:	Radiation, C9037-328

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
29	S118	SWITCH, pushbutton:	Radiation, C9037-328
30	S117	SWITCH, pushbutton:	Radiation, C9037-328
31	S116	SWITCH, pushbutton:	Radiation, C9037-328
32	S115	SWITCH, pushbutton:	Radiation, C9037-328
33		BRACKET, mounting, pushbutton:	Radiation, B9037-301
34	S105	SWITCH, rotary:	Radiation, C9037-319
35	J102	SOCKET, relay:	Radiation, B9037-303
36	S104	SWITCH, rotary:	Radiation, C9037-308
37	R129	RESISTOR, variable, composition: 1k, ±10%, 3/4" shaft:	Chicago Telephone Supply, FR6651
38	R290/S101	RESISTOR, variable, composition: 100k, 1/2w, 3/4" shaft, with DPST switch	Chicago Telephone Supply, HR4102
39	R289	RESISTOR, fixed, composition: 110k, ±5%, 1/2w	RC20GF114J
40	I1	LAMPHOLDER, red lens: LAMP, incandescent:	Drake, 220-1-1L General Electric, 1891
41		PANEL, front, transmitter:	Radiation, D9037-122-1

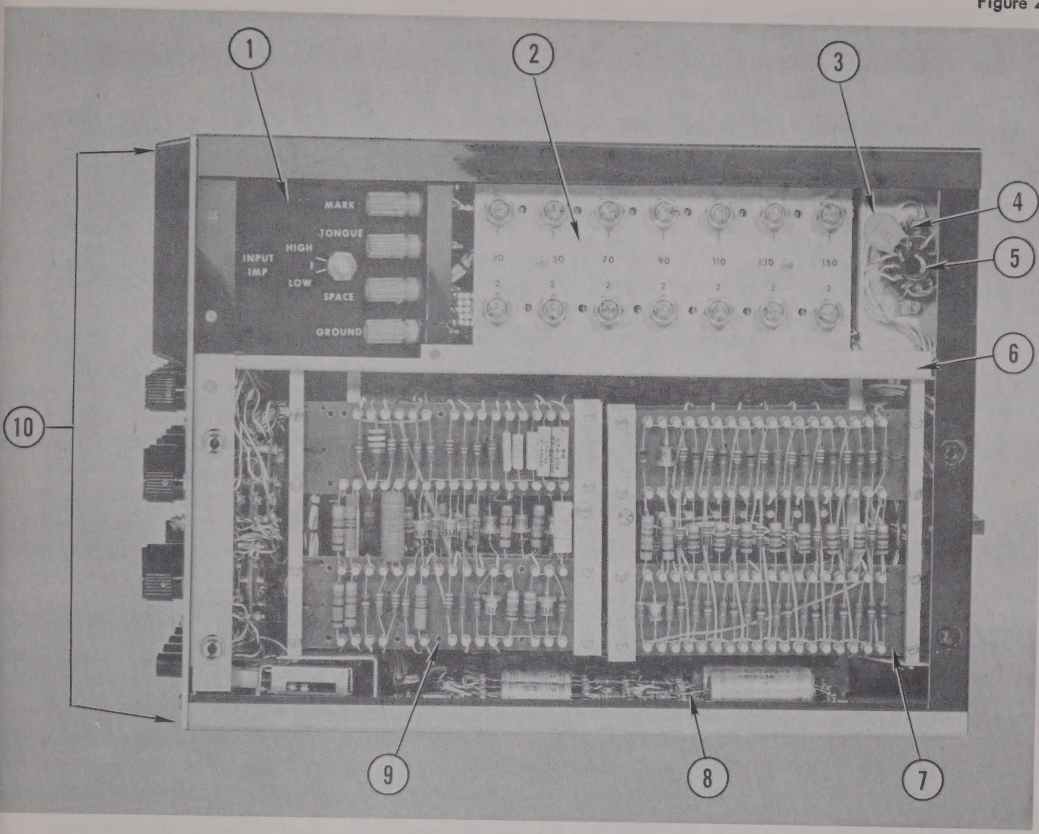

Figure 2-6. Transmitter Right Side Interior

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1		BRACKET, binding post, recessed, right side:	Radiation, C9037-323-1
2		BRACKET, upper potentiometer:	Radiation, D9037-108
3	C166	CAPACITOR, ceramic, disc: 0.02 mfd, ±20%, 600v	Radio Materials Co., B.02-718Z5U
4	R348	RESISTOR, fixed, composition: 1k, 1/2w	RC20GF102J
5		SOCKET, coder: 11-pin	Amphenol, 77-MIP-11
6		DECK, top:	Radiation, D9037-330
7	TB14 and 15	BOARD, terminal: door "C"	See Figure 2-14
8	TB18	BOARD, terminal: TB18	See Figure 2-19
9	TB11 and 12	BOARD, terminal: door "A"	See Figure 2-13
10		PANEL, front, control:	See Figure 2-2

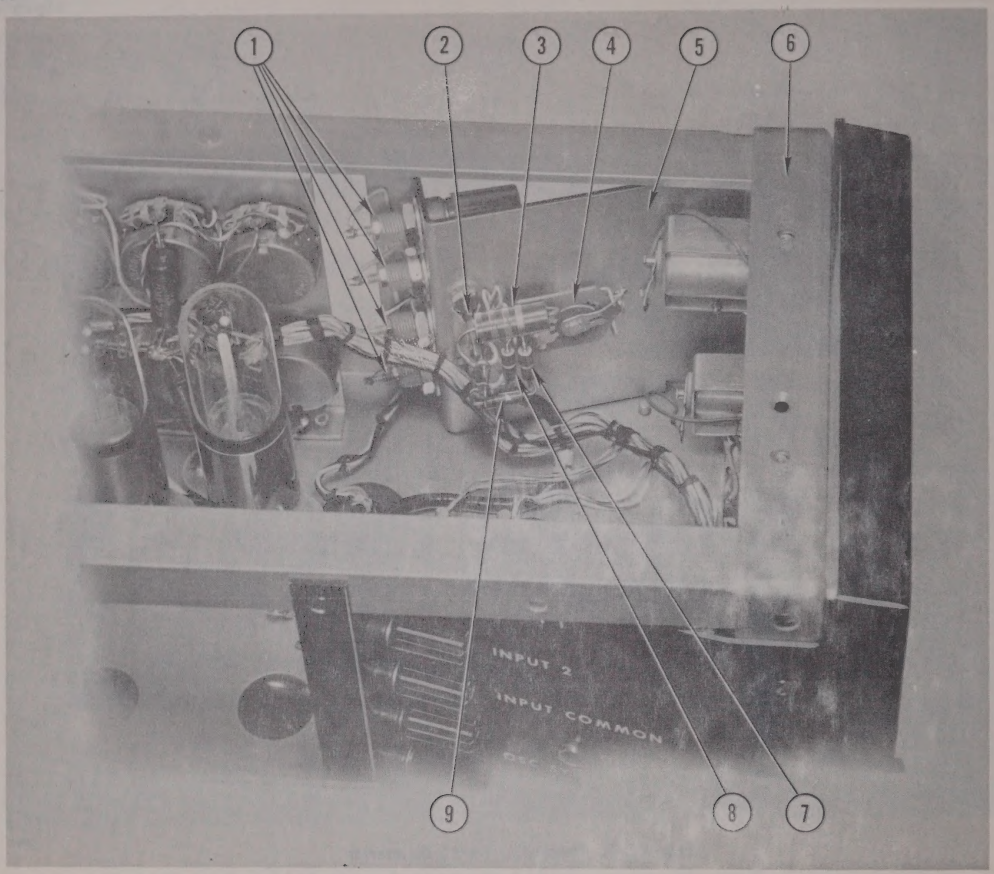

Figure 2-7. Transmitter Input Impedance Switch, S111

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1		POST, binding: red with nut (4)	E.F. Johnson, 111-102
2	TP11 (tie point)	STRIP, terminal: XXXP	Cinch, 2002
3	R102	RESISTOR, fixed, composition: 2w, ±5%, 270 ohms	RC42GF271J
4	S11	SWITCH, rotary:	Radiation, C9037-305
5		BRACKET, binding post, recessed, right side:	Radiation, C9037-323-1
6		PANEL LIP, front:	Radiation, 9037-322-2
7	R104	RESISTOR, fixed, composition: 1/2w, ±5%, 220k	RC20GF221J
8	R101	RESISTOR, fixed, composition: 1/2w, ±5%, 220k	RC20GF221J
9	R103	RESISTOR, fixed, composition: 1/2w, ±5%, 2 meg	RC20GF205J

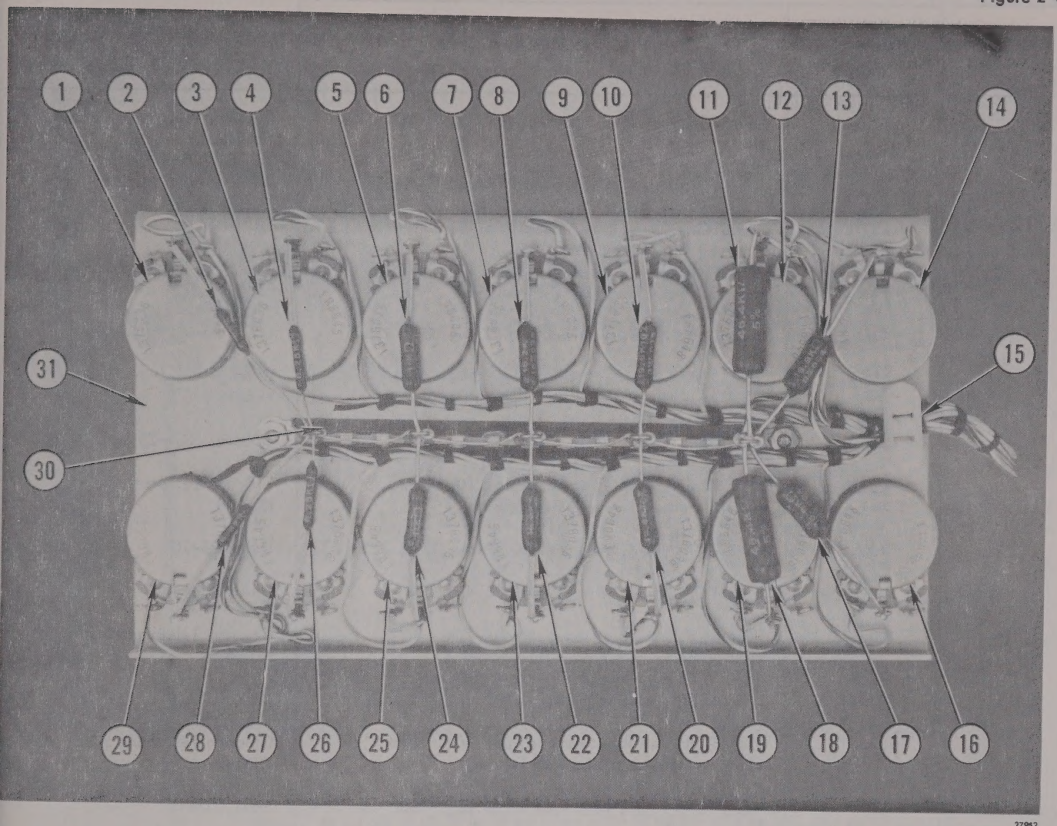

Figure 2-8. Transmitter Upper Potentiometer Bracket

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1	R335	RESISTOR, variable, composition: 5k, ±10%, slotted shaft, lock type	Chicago Telephone Supply, FR6645
2	R321	RESISTOR, fixed, wire wound: 5.62k, ±10%, 1w	Dale, CS-1A
3	R333	RESISTOR, variable, composition: 5k, ±10%, slotted shaft, lock type	Chicago Telephone Supply, FR6645
4	R319	RESISTOR, fixed, wire wound: 8.25k, ±10%, 1w	Dale, CS-1B
5	R331	RESISTOR, variable, composition: 5k, ±10%, slotted shaft, lock type	Chicago Telephone Supply, FR6645
6	R317	RESISTOR, fixed, wire wound: 11.0k, ±10%, 1w	Dale, CS-2B
7	R329	RESISTOR, variable, composition: 5k, ±10%, slotted shaft, lock type	Chicago Telephone Supply, FR6645
8	R315	RESISTOR, fixed, wire wound: 16.2k, ±10%, 1w	Dale, CS-2B

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
9	R327	RESISTOR, variable, composition: 5k, ±10%, slotted shaft, lock type	Chicago Telephone Supply, FR6645
10	R313	RESISTOR, fixed, wire wound: 19.6k, ±10%, 1w	Dale, CS-2B
11	R311	RESISTOR, fixed, wire wound: 46.4k, ±5%, 5w	Dale, CS-5
12	R325	RESISTOR, variable, composition: 10k, ±10%, slotted shaft, lock type with lock nut	Chicago Telephone Supply, FR6648
13	R309	RESISTOR, fixed, wire wound: 19.6k, ±3%, 2.5w	Dale, RS-2C
14	R323	RESISTOR, variable, composition: 10k, ±10%, slotted shaft, lock type with lock nut	Chicago Telephone Supply, FR6648
15		KEEPER:	Dakota, 2C1-25-B
16	R322	RESISTOR, variable, composition: 10k, ±10%, slotted shaft, lock type with lock nut	Chicago Telephone Supply, FR6648
17	R308	RESISTOR, fixed, wire wound: 19.6k, ±3%, 2.5w	Dale, RS-2C
18	R310	RESISTOR, fixed, wire wound: 46.4k, ±5%, 5w	Dale, CS-5
19	R324	RESISTOR, variable, composition: 10k, ±10%, slotted shaft, lock type with lock nut	Chicago Telephone Supply, FR6648
20	R312	RESISTOR, fixed, wire wound: 19.6k, ±10%, 1w	Dale, CS-2B
21	R326	RESISTOR, variable, composition: 10k, ±10%, slotted shaft, lock type with lock nut	Chicago Telephone Supply, FR6648
22	R314	RESISTOR, fixed, wire wound: 16.2k, ±10%, 1w	Dale, CS-2B
23	R328	RESISTOR, variable, composition: 5k, ±10%, slotted shaft, lock type with lock nut	Chicago Telephone Supply, FR6645
24	R316	RESISTOR, fixed, wire wound: 11.0k, ±10%, 1w	Dale, CS-2B
25	R330	RESISTOR, variable, composition: 5k, ±10%, slotted shaft, lock type with lock nut	Chicago Telephone Supply, FR6645
26	R318	RESISTOR, fixed, wire wound: 8.25k, ±10%, 1w	Dale, CS-1B
27	R332	RESISTOR, variable, composition: 5k, ±10%, slotted shaft, lock type with lock nut	Chicago Telephone Supply, FR6645
28	R320	RESISTOR, fixed, wire wound: 5.62k, ±10%, 1w	Dale, CS-1A
29	R334	RESISTOR, variable, composition: 5k, ±10%, 1w, slotted shaft, lock type with lock nut	Chicago Telephone Supply, FR6645
30	TP10 (tie point)	STRIP, terminal: XXXP, phenolic	Cinch, 2013
31		BRACKET, upper potentiometer:	Radiation, D9037-108

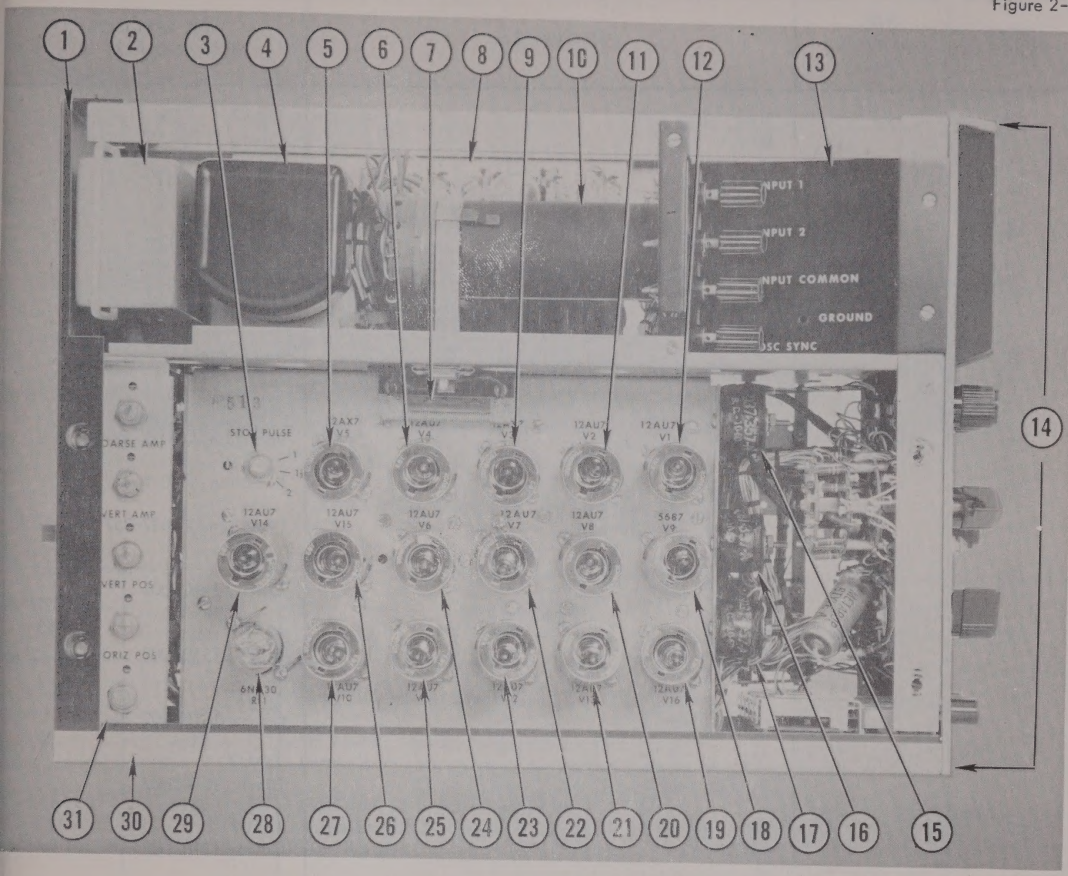

Figure 2-9. Transmitter Left Side Interior

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1		COVER, rear:	See Figure 2-4
2		CODER:	See Figure 2-20
3	S112	SWITCH, rotary:	Radiation, C9037-304
4		RELAY, polar:	See Figure 2-11
5	V5	TUBE, electron: SHIELD, tube:	12AX7 Cinch, TS103U02
6	V4	TUBE, electron: SHIELD, tube:	12AU7 Cinch, TS103U02
7		RELAY, thermal (surgistor):	Wurth Tube Saver Corp., 4002-5
8		BRACKET, rear potentiometer:	See Figure 2-10

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
9	V3	TUBE, electron: SHIELD, tube:	12AX7 Cinch, TS103U02
10		CRT, tube:	See Figure 2-11
11	V2	TUBE, electron: SHIELD, tube:	12AU7 Cinch, TS103U02
12	V1	TUBE, electron: SHIELD, tube:	12AU7 Cinch, TS103U02
13		BRACKET, binding post, left side:	See Figure 2-3
14		PANEL, front, control:	See Figure 2-1
15		CHOKE, line, filter:	Radiation, A9037-357
16		CHOKE, line, filter:	Radiation, A9037-357
17		CHOKE, line, filter:	Radiation, A9037-357
18	V9	TUBE, electron: SHIELD, tube:	5687 Cinch, TS103U02
19	V16	TUBE, electron: SHIELD, tube:	12AU7 Cinch, TS103U02
20	V8	TUBE, electron: SHIELD, tube:	12AU7 Cinch, TS103U02
21	V13	TUBE, electron: SHIELD, tube:	12AU7 Cinch, TS103U02
22	V7	TUBE, electron: SHIELD, tube:	12AU7 Cinch, TS103U02
23	V12	TUBE, electron: SHIELD, tube:	12AU7 Cinch, TS103U02
24	V6	TUBE, electron: SHIELD, tube:	12AU7 Cinch, TS103U02
25	V11	TUBE, electron: SHIELD, tube:	12AU7 Cinch, TS103U02
26	V15	TUBE, electron: SHIELD, tube:	12AU7 Cinch, TS103U02
27	V10	TUBE, electron: SHIELD, tube:	12AU7 Cinch, TS103U02
28	RL1	RELAY, thermal: CLIP, tube:	Amperite, 6N030T Remler, W73819
29	V14	TUBE, electron: SHIELD, tube:	12AU7 Cinch, TS103U02
30		COVER, bottom:	Radiation, D9037-1310-2
31		BRACKET, rear potentiometer:	See Figure 2-10

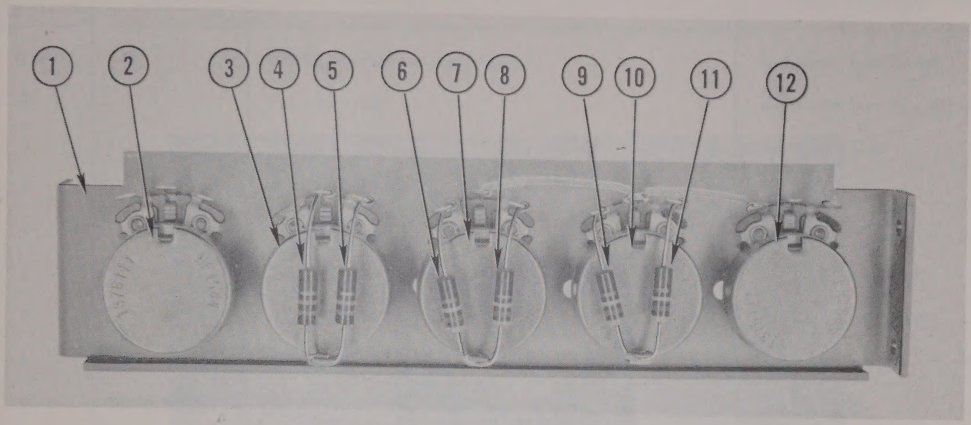

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Figure 2-10. Transmitter Rear Potentiometer Bracket

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1		BRACKET, rear potentiometer:	Radiation, B9037-359
2	R128	RESISTOR, variable, composition: 10k, ±10%, slotted shaft 1/2" long, 3/8" bushing	Chicago Telephone Supply, HF1544
3	R165	RESISTOR, variable, composition: 5k, ±10%, slotted shaft 1/2" long, 3/8" bushing, locking type with lock nut	Chicago Telephone Supply, FR6645
4	R164	RESISTOR, fixed, composition: 1/2w, ±5%, 56k	RC20GF563J
5	R166	RESISTOR, fixed, composition: 1/2w, ±5%, 56k	RC20GF563J
6	R170	RESISTOR, fixed, composition: 1/2w, ±5%, 470k	RC20GF474J
7	R171	RESISTOR, variable, composition: 1 meg, ±10%, slotted shaft 1/2" long, 3/8" bushing	Chicago Telephone Supply, FR6646
8	R172	RESISTOR, fixed, composition: 1/2w, ±5%, 470k	RC20GF474J
9	R135	RESISTOR, fixed, composition: 1/2w, ±5%, 470k	RC20GF474J
10	R136	RESISTOR, variable, composition: 1 meg, ±10%, slotted shaft 1/2" long, 3/8" bushing	Chicago Telephone Supply, FR6646
11	R137	RESISTOR, fixed, composition: 1/2w, ±5%, 470k	RC20GF474J
12	R285	RESISTOR, variable, composition: 1 meg, ±10%, slotted shaft 1/2" long, 3/8" bushing	Chicago Telephone Supply, FR6646

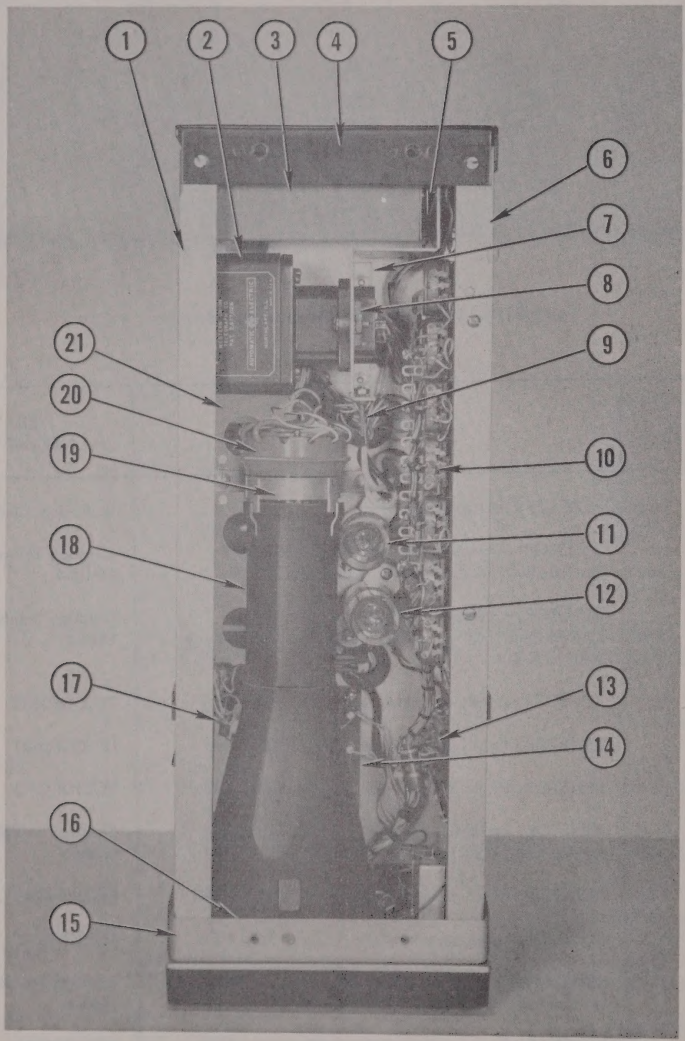

Figure 2-11. Transmitter Top View Interior

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1		BRACE, top support, left side:	Radiation, C9037-110
2		RELAY, polar:	Automatic Electric, 202-A
3		CODER:	See Figure 2-20
4		COVER, rear:	See Figure 2-4
5		SOCKET, coder: 11-pin	Amphenol, 77-MIP-11
6		BRACE, top support, right side:	Radiation C9037-130
7		BRACKET, relay and coder:	Radiation C9037-339
8		SOCKET, relay:	Automatic Electric, RN-88
9	TP4 (tie point)	STRIP, terminal: XXP, phenolic	Cinch, 2004
10		BRACKET, rear potentiometer:	See Figure 2-10
11		LAMP, incandescent:	Sylvania, 15T7N
12		LAMP, incandescent:	Sylvania, 15T7N
13		BRACKET, binding post, right side:	See Figure 2-7
14	TB19	BOARD, terminal:	See Figure 2-12
15		PANEL LIP, front:	Radiation, D9037-322-2
16		BUMPER (3) (under lip):	Atlantic India Rubber Co., 783
17		BRACKET, binding post, left side:	See Figure 2-3
18		CRT, tube (under shield): SHIELD, CRT:	RCA, 3RP1 Radiation, D9037-704
19		CLAMP, CRT:	Radiation, B9037-705
20		SOCKET, CRT, duodecal:	Cinch, 3M-12
21		DECK, top:	Radiation, D9037-330

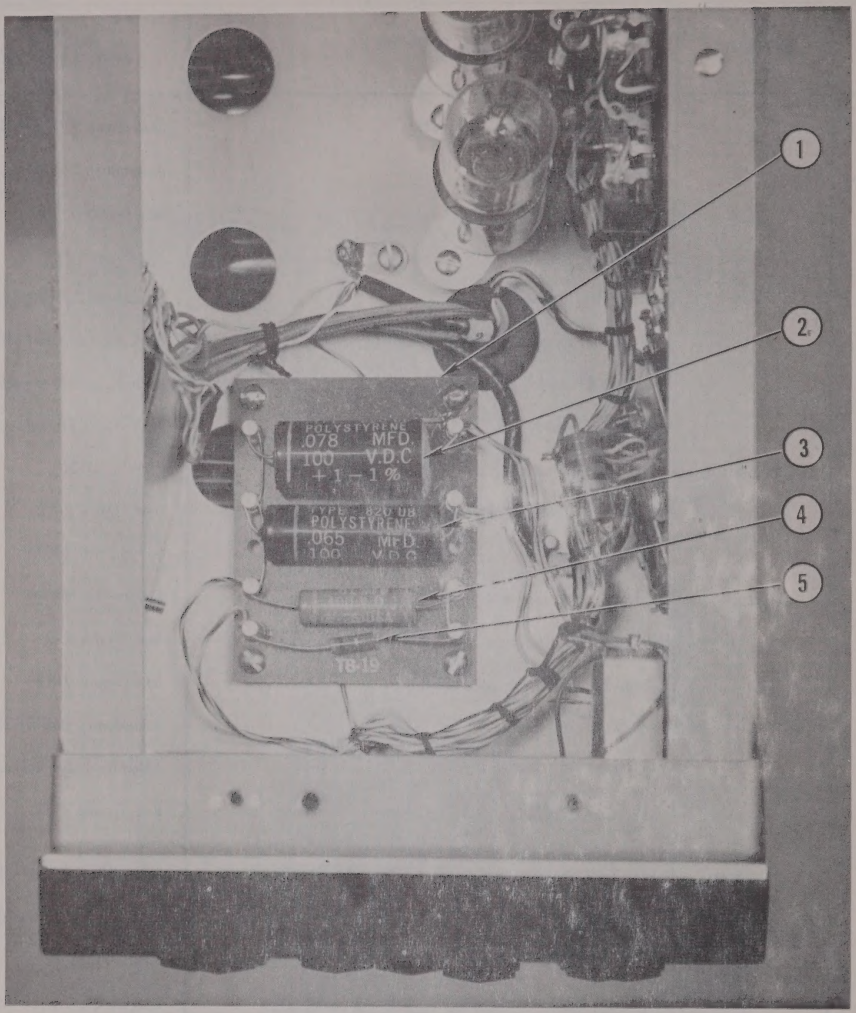

Figure 2-12. Transmitter Terminal Board, TB19

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1	TB19	BOARD, terminal:	Radiation, A9037-842
2	C114	CAPACITOR, fixed, polyvinyl: 0.07 mf ± 1%, 100v	Good-All, 820UB78311W2
3	C113	CAPACITOR: 0.65 mf, ±1%, 100v	Good-All, 820UB65311W2
4	C111	CAPACITOR: 0.01 mf, ±20%, 400v	Cornell-Dubilier, PJ4S1
5	R162	RESISTOR, fixed, composition: 1/2w, ±5%, 1m	RC20GF105J

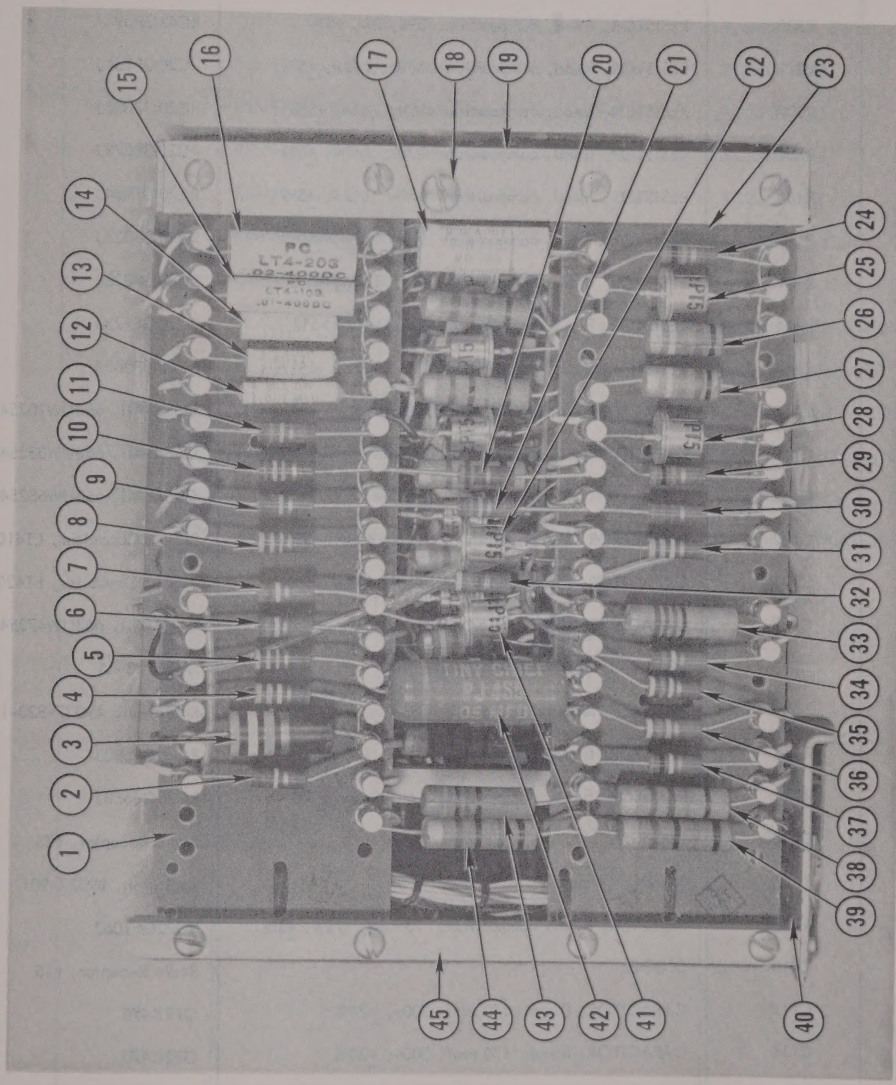

Figure 2-13. Transmitter Terminal Board, "A" Door

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1	TB11	BOARD, terminal:	Radiation, D9037-900
2	R183	RESISTOR, fixed, composition: 220k, 1/2w, ±5%	RC20GF224J
3	R220	RESISTOR, fixed, composition: 39k, 2w, ±5%	RC42GF393J
4	R211	RESISTOR, fixed, composition: 330k, 1/2w, ±5%	RC20GF334J
5	R122	RESISTOR, fixed, composition: 39k, 1/2w, ±5%	RC20GF333J
6	R287	RESISTOR, fixed, composition: 270k, 1/2w, ±5%	RC20GF273J
7	R184	RESISTOR, fixed, composition: 150k, 1/2w, ±5%	RC20GF154J
8	R117	RESISTOR, fixed, composition: 33k, 1/2w, ±5%	RC20GF333J
9	R111	RESISTOR, fixed, composition: 22k, 1/2w, ±5%	RC20GF223J
10	R214	RESISTOR, fixed, composition: 27k, 1/2w, ±5%	RC20GF273J
11	R127	RESISTOR, fixed, composition: 56k, 1/2w, ±5%	RC20GF563J
12	C170	CAPACITOR, fixed: 0.001 mf, 400v, ±5%	Good-All, 663UW10254W2
13	C169	CAPACITOR, fixed, mylar: 0.0033 mf, 400v, ±5%	Good-All, 663UW33254W2
14	C168	CAPACITOR, fixed, mylar: 0.0068 mf, 400v, ±5%	Good-All, 663UW68254W2
15	C132	CAPACITOR, fixed, mylar: 0.01 mf, 400v, ±5%	Plastic Capacitor, LT4103
16	C131	CAPACITOR, fixed, mylar: 0.02 mf, 400v, ±5%	Plastic Capacitor, LT4203
17	C167	CAPACITOR, fixed, mylar: 0.047 mf, 400v, ±5%	Good-All, 663UW47354W2
18		SCREW: 6/32 x 1-1/4, pheres	MS35233-35
19		BRACKET, terminal board:	Radiation, A9037-823-1
20	R176	RESISTOR, fixed, composition: 6.8k, 1/2w, ±5%	RC20GF682J
21	R131	RESISTOR, fixed, composition: 56k, 1/2w, ±5%	RC20GF563J
22	CR108	DIODE:	Radio Receptor, PT5
23	TB12	BOARD, terminal:	Radiation, B9037-901
24	R186	RESISTOR, fixed, composition: 10 meg, 1/2w, ±5%	RC20GF106J
25	CR107	DIODE:	Radio Receptor, PT5
26	C117	CAPACITOR, fixed: 470 mmf, 500v, ±20%	GP2K470
27	C116	CAPACITOR, fixed: 470 mmf, 500v, ±20%	GP2K470
28	CR106	DIODE:	Radio Receptor, PT5
29	R185	RESISTOR, fixed, composition: 10 meg, 1/2w, ±5%	RC20GF106J
30	R130	RESISTOR, fixed, composition: 2.2k, 1/2w, ±5%	RC20GF222J

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
31	R306	RESISTOR, fixed, composition: 330k, 1/2w, ±5%	RC20GF334J
32	R194	RESISTOR, fixed, composition: 4.7 meg, 1/2w, ±5%	RC20GF475J
33	C123	CAPACITOR: 1500 mmf, 500v, ±20%	Erie Resistor Corp., GP2L1500
34	R300	RESISTOR, fixed, composition: 270k, 1/2w, ±5%	RC20GF274J
35	R298	RESISTOR, fixed, composition: 470k, 1/2w, ±5%	RC20GF474J
36	R299	RESISTOR, fixed, composition: 47k, 1/2w, ±5%	RC20GF473J
37	R297	RESISTOR, fixed, composition: 100k, 1/2w, ±5%	RC20GF104J
38	C155	CAPACITOR: 1500 mmf, 500v, ±20%	Erie Resistor Corp., GP2L1500
39	C156	CAPACITOR: 1000 mmf, 500v, ±20%	Erie Resistor Corp., GP2L1000
40		BRACKET, terminal board:	Radiation, 9037-348
41	CR109	DIODE:	Radio Receptor, PT5
42	C108	CAPACITOR: 0.05 mf, 400v, ±20%	Cornell-Dubilier, PJ4S5
43	C172	CAPACITOR: 3000 mmf, 500v, ±20%	Erie Resistor Corp., GP3L3000
44	C171	CAPACITOR: 1000 mmf, 500v, ±20%	Erie Resistor Corp., GP2L1000
45		PIVOT, terminal board:	Radiation, B9037-392

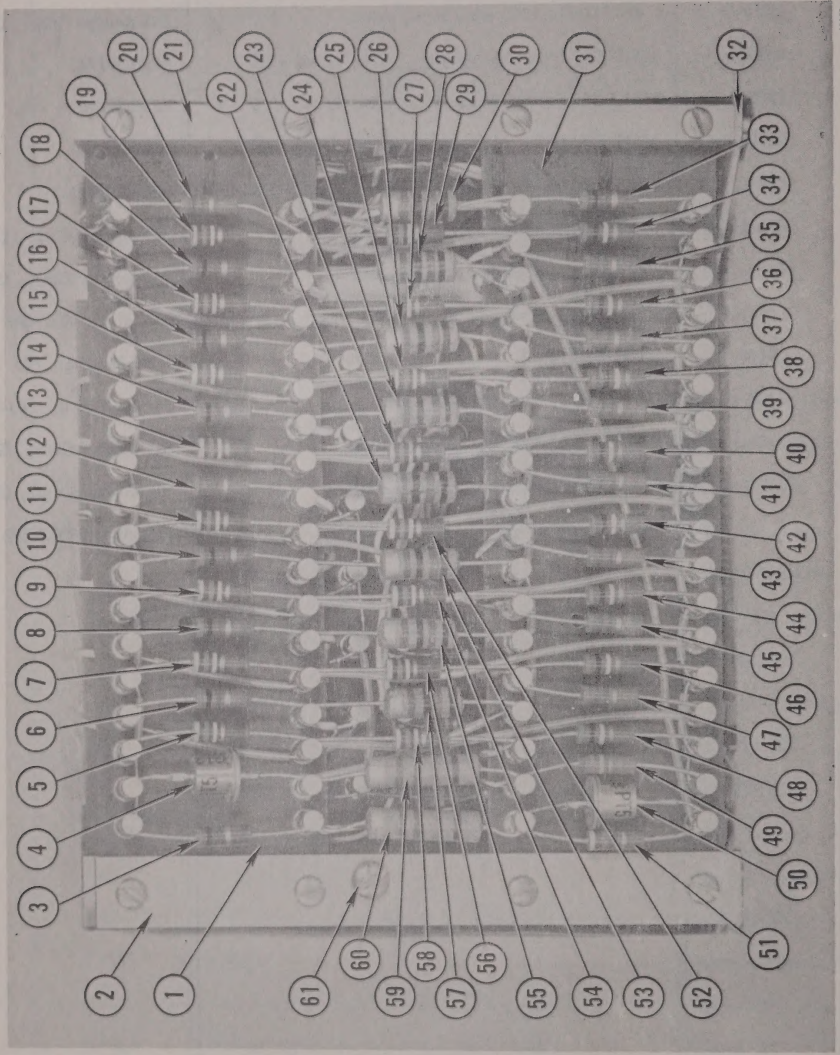

Figure 2-14. Transmitter Terminal Board, "C" Door

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1	TB14	BOARD, terminal:	Radiation, B9037-902
2		BRACKET, terminal board:	Radiation, A9037-823-2
3	R207	RESISTOR, fixed, composition: 1m, 1/2w, ±5%	RC20GF105J
4	CR126	DIODE:	Radio Receptor, PT5
5	R258	RESISTOR, fixed, composition: 470k, 1/2w, ±5%	RC20GF474J
6	R242	RESISTOR, fixed, composition: 1m, 1/2w, ±5%	RC20GF105J
7	R253	RESISTOR, fixed, composition: 470k, 1/2w, ±5%	RC20GF474J
8	R237	RESISTOR, fixed, composition: 1m, 1/2w, ±5%	RC20GF105J
9	R248	RESISTOR, fixed, composition: 470k, 1/2w, ±5%	RC20GF474J
10	R232	RESISTOR, fixed, composition: 1m, 1/2w, ±5%	RC20GF105J
11	R243	RESISTOR, fixed, composition: 470k, 1/2w, ±5%	RC20GF474J
12	R227	RESISTOR, fixed, composition: 1.2m, 1/2w, ±5%	RC20GF125J
13	R238	RESISTOR, fixed, composition: 470k, 1/2w, ±5%	RC20GF474J
14	R222	RESISTOR, fixed, composition: 1m, 1/2w, ±5%	RC20GF105J
15	R233	RESISTOR, fixed, composition: 470k, 1/2w, ±5%	RC20GF474J
16	R257	RESISTOR, fixed, composition: 1m, 1/2w, ±5%	RC20GF105J
17	R228	RESISTOR, fixed, composition: 470k, 1/2w, ±5%	RC20GF474J
18	R252	RESISTOR, fixed, composition: 1m, 1/2w, ±5%	RC20GF105J
19	R223	RESISTOR, fixed, composition: 470k, 1/2w, ±5%	RC20GF474J
20	R221	RESISTOR, fixed, composition: 1.5m, 1/2w, ±5%	RC20GF155J
21		PIVOT, terminal board:	Radiation, B9037-392
22	C136	CAPACITOR: 100 mmf, 500v, ±20%	Erie Resistor Corp., GF1K100
23	R239	RESISTOR, fixed, composition: 470k, 1/2w, ±5%	RC20GF474J
24	C135	CAPACITOR: 100 mmf, 500v, ±20%	Erie Resistor Corp., GF1K100
25	R234	RESISTOR, fixed, composition: 470k, 1/2w, ±5%	RC20GF474J
26	C142	CAPACITOR: 100 mmf, 500v, ±20%	Erie Resistor Corp., GF1K100
27	R229	RESISTOR, fixed, composition: 470k, 1/2w, ±5%	RC20GF474J
28	C141	CAPACITOR: 100 mmf, 500v, ±20%	Erie Resistor Corp., GF1K100
29	R224	RESISTOR, fixed, composition: 470k, 1/2w, ±5%	RC20GF474J
30	C140	CAPACITOR: 100 mmf, 500v, ±20%	Erie Resistor Corp., GF1K100
31	TB15	BOARD, terminal:	Radiation, B9037-903

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
32		BRACKET, terminal board:	Radiation, 9037-349
33	R247	RESISTOR, fixed, composition: 1m, 1/2w, ±5%	RC20GF105J
34	R225	RESISTOR, fixed, composition: 100k, 1/2w, ±5%	RC20GF104J
35	R226	RESISTOR, fixed, composition: 1.5m, 1/2w, ±5%	RC20GF155J
36	R230	RESISTOR, fixed, composition: 100k, 1/2w, ±5%	RC20GF104J
37	R231	RESISTOR, fixed, composition: 1.5m, 1/2w, ±5%	RC20GF155J
38	R235	RESISTOR, fixed, composition: 100k, 1/2w, ±5%	RC20GF104J
39	R236	RESISTOR, fixed, composition: 1.5m, 1/2w, ±5%	RC20GF155J
40	R240	RESISTOR, fixed, composition: 100k, 1/2w, ±5%	RC20GF104J
41	R241	RESISTOR, fixed, composition: 1.5m, 1/2w, ±5%	RC20GF155J
42	R245	RESISTOR, fixed, composition: 100k, 1/2w, ±5%	RC20GF104J
43	R246	RESISTOR, fixed, composition: 1.5m, 1/2w, ±5%	RC20GF155J
44	R250	RESISTOR, fixed, composition: 100k, 1/2w, ±5%	RC20GF104J
45	R251	RESISTOR, fixed, composition: 1.5m, 1/2w, ±5%	RC20GF155J
46	R255	RESISTOR, fixed, composition: 100k, 1/2w, ±5%	RC20GF104J
47	R256	RESISTOR, fixed, composition: 1.5m, 1/2w, ±5%	RC20GF155J
48	R260	RESISTOR, fixed, composition: 100k, 1/2w, ±5%	RC20GF104J
49	R272	RESISTOR, fixed, composition: 56k, 1/2w, ±5%	RC20GF563J
50	CR115	DIODE:	Radio Receptor, PT5
51	R205	RESISTOR, fixed, composition: 4.7m, 1/2w, ±5%	RC20GF475J
52	R244	RESISTOR, fixed, composition: 470k, 1/2w, ±5%	RC20GF474J
53	C137	CAPACITOR: 100 mmf, 500v, ±20%	Erie Resistor Corp., GF1K100
54	R249	RESISTOR, fixed, composition:470k, 1/2w, ±5%	RC20GF474J
55	C138	CAPACITOR: 100 mmf, 500v, ±20%	Erie Resistor Corp., GF1K100
56	R254	RESISTOR, fixed, composition: 470k, 1/2w, ±5%	RC20GF474J
57	C139	CAPACITOR: 100 mmf, 500v, ±20%	Erie Resistor Corp., GF1K100
58	R259	RESISTOR, fixed, composition: 470k, 1/2w, ±5%	RC20GF474J
59	C148	CAPACITOR: 1500 mmf, 500v, ±20%	Erie Resistor Corp., GP2L1500
60	C129	CAPACITOR: 1500 mmf, 500v, ±20%	Erie Resistor Corp., GP2L1500
61		SCREW: 6/32 x 1-1/4, ph cres	MS35233-35

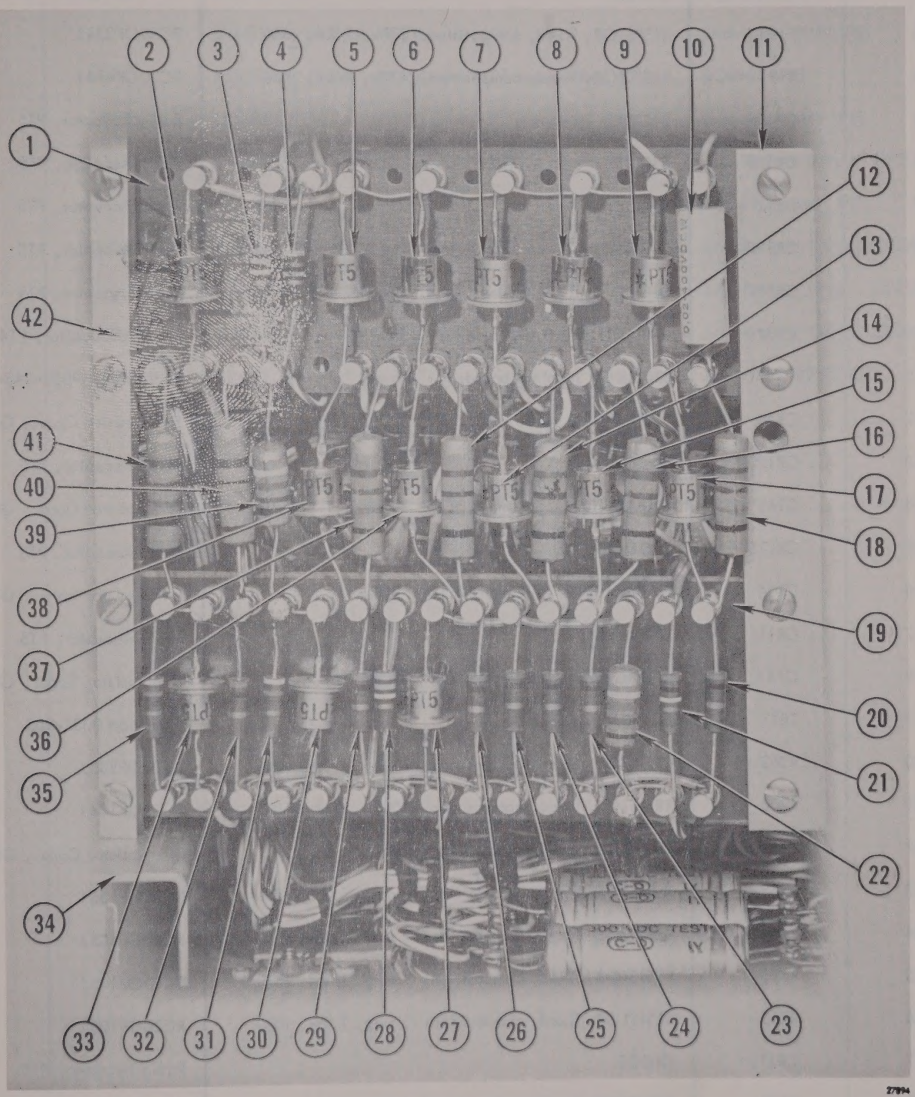

Figure 2-15. Transmitter Terminal Board, "B" Door

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1	TB16	BOARD, terminal:	Radiation, 9037-904
2	CR114	DIODE:	Radio Receptor, PT5
3	R192	RESISTOR, fixed, composition: 330k, 1/2w, ±5%	RC20GF334J
4	R191	RESISTOR, fixed, composition: 470k, 1/2w, ±5%	RC20GF474J
5	CR125	DIODE:	Radio Receptor, PT5
6	CR123	DIODE:	Radio Receptor, PT5
7	CR121	DIODE:	Radio Receptor, PT5
8	CR119	DIODE:	Radio Receptor, PT5
9	CR117	DIODE:	Radio Receptor, PT5
10	C134	CAPACITOR: 0.02 mf, 400v, ±5%	Plastic Capacitor, LT4-203
11		BRACKET, terminal board:	Radiation, B9037-343-2
12	C146	CAPACITOR: 1500 mmf, 500v, ±20%	Erie Resistor Corp., GP2L1500
13	CR120	DIODE:	Radio Receptor, PT5
14	C145	CAPACITOR: 1500 mmf, 500v, ±20%	Erie Resistor Corp., GP2L1500
15	CR118	DIODE:	Radio Receptor, PT5
16	C144	CAPACITOR: 1500 mmf, 500v, ±20%	Erie Resistor Corp., GP2L1500
17	CR116	DIODE:	Radio Receptor, PT5
18	C143	CAPACITOR: 1500 mmf, 500v, ±20%	Erie Resistor Corp., GP2L1500
19	TB17	BOARD, terminal:	Radiation 9037-905
20	R262	RESISTOR, fixed, composition: 1 meg, 1/2w, ±5%	RC20GF105J
21	R200	RESISTOR, fixed, composition: 100k, 1/2w, ±5%	RC20GF104J
22	C125	CAPACITOR: 470 mmf, 500v, ±20%	Erie Resistor Corp., GP2K470
23	R263	RESISTOR, fixed, composition: 1 meg, 1/2w, ±5%	RC20GF105J
24	R264	RESISTOR, fixed, composition: 1 meg, 1/2w, ±5%	RC20GF105J
25	R196	RESISTOR, fixed, composition: 1 meg, 1/2w, ±5%	RC20GF105J
26	R265	RESISTOR, fixed, composition: 1 meg, 1/2w, ±5%	RC20GF105J
27	CR111	DIODE:	Radio Receptor, PT5
28	R178	RESISTOR, fixed, composition: 330k, 1/2w, ±5%	RC20GF334J
29	R266	RESISTOR, fixed, composition: 1 meg, 1/2w, ±5%	RC20GF105J
30	CR110	DIODE:	Radio Receptor, PT5
31	R198	RESISTOR, fixed, composition: 4.7 meg, 1/2w, ±5%	RC20GF475J

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
32	R203	RESISTOR, fixed, composition: 1 meg, 1/2w, ±5%	RC20GF105J
33	CR113	DIODE:	Radio Receptor, PT5
34		BRACKET, terminal board:	Radiation, 9037-348
35	R199	RESISTOR, fixed, composition: 4.7 meg, 1/2w, ±5%	RC20GF475J
36	CR122	DIODE:	Radio Receptor, PT5
37	C147	CAPACITOR: 1500 mmf, 500v, ±20%	Erie Resistor Corp., GP2L1500
38	CR124	DIODE:	Radio Receptor, PT5
39	C124	CAPACITOR: 470 mmf, 500v, ±20%	Erie Resistor Corp., GP2K470
40	C128	CAPACITOR: 1000 mmf, 500v, ±20%	Erie Resistor Corp., GP2L1000
41	C127	CAPACITOR: 1500 mmf, 500v, ±20%	Erie Resistor Corp., GP2L1500
42		PIVOT, terminal board:	Radiation, B9037-392

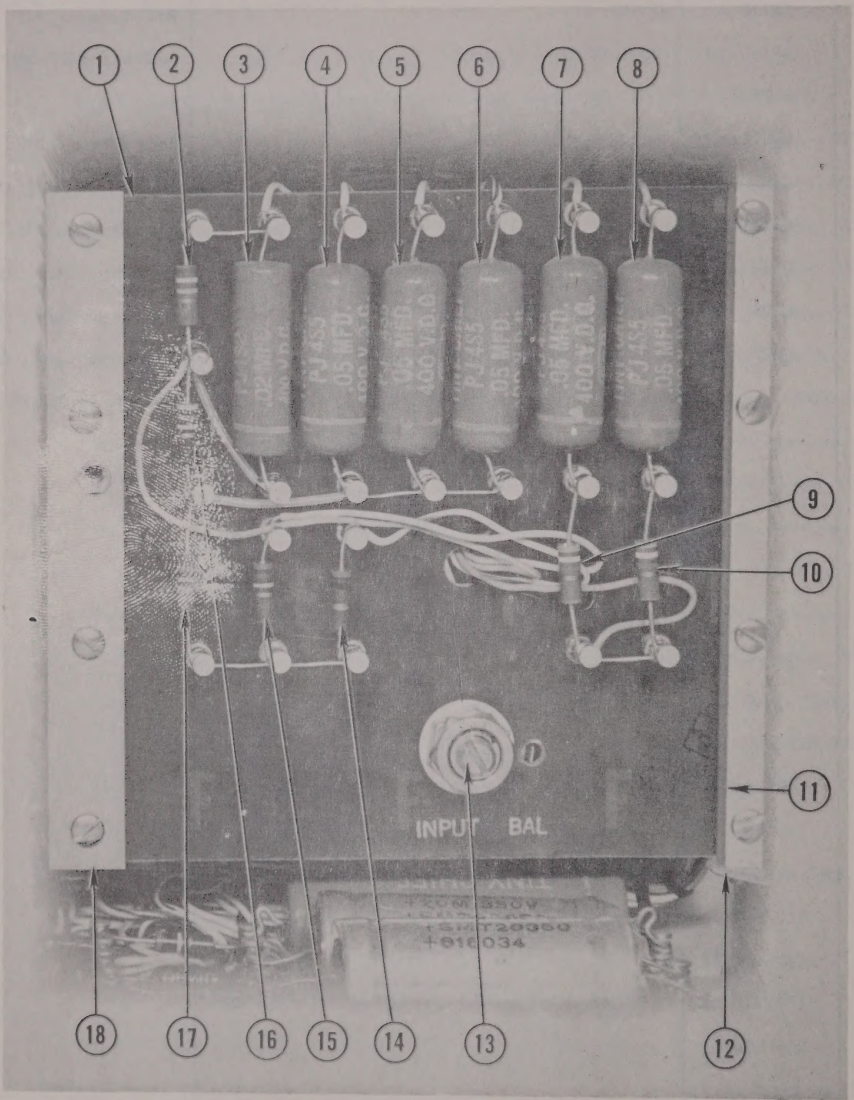

Figure 2-16. Transmitter Terminal Board, "D" Door

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1	TB13	BOARD, terminal:	Radiation, C9037-838
2	R267	RESISTOR, fixed, composition: 24k, 1/2w, ±5%	RC20GF243J
3	C151	CAPACITOR: 0.02 mf, 400v, ±20%	Cornell-Dubilier, PJ452
4	C122	CAPACITOR: 0.05 mf, 400v, ±20%	Cornell-Dubilier, PJ455
5	C121	CAPACITOR: 0.05 mf, 400v, ±20%	Cornell-Dubilier, PJ455
6	C120	CAPACITOR: 0.05 mf, 400v, ±20%	Cornell-Dubilier, PJ455
7	C119	CAPACITOR: 0.05 mf, 400v, ±20%	Cornell-Dubilier, PJ455
8	C118	CAPACITOR: 0.05 mf, 400v, ±20%	Cornell-Dubilier, PJ455
9	R188	RESISTOR, fixed, composition: 390 ohms, 1/2w, ±5%	RC20GF391J
10	R187	RESISTOR, fixed, composition: 390 ohms, 1/2w, ±5%	RC20GF391J
11		PIVOT, terminal board:	Radiation, B9037-392
12		BRACKET, terminal board, rear:	Radiation, 9037-349
13	R301	RESISTOR, variable, composition: 100k, ±20%, 1/2w, with lock nut	Chicago Telephone Supply, HR4104
14	R283	RESISTOR, fixed, composition: 1m, 1/2w, ±5%	RC20GF105J
15	R282	RESISTOR, fixed, composition: 12k, 1/2w, ±5%	RC20GF123J
16	R262	RESISTOR, fixed, composition: 470k, 1/2w, ±5%	RC20GF474J
17	R281	RESISTOR, fixed, composition: 27k, 1/2w, ±5%	RC20GF273J
18		BRACKET, terminal board:	Radiation, A9037-343-2

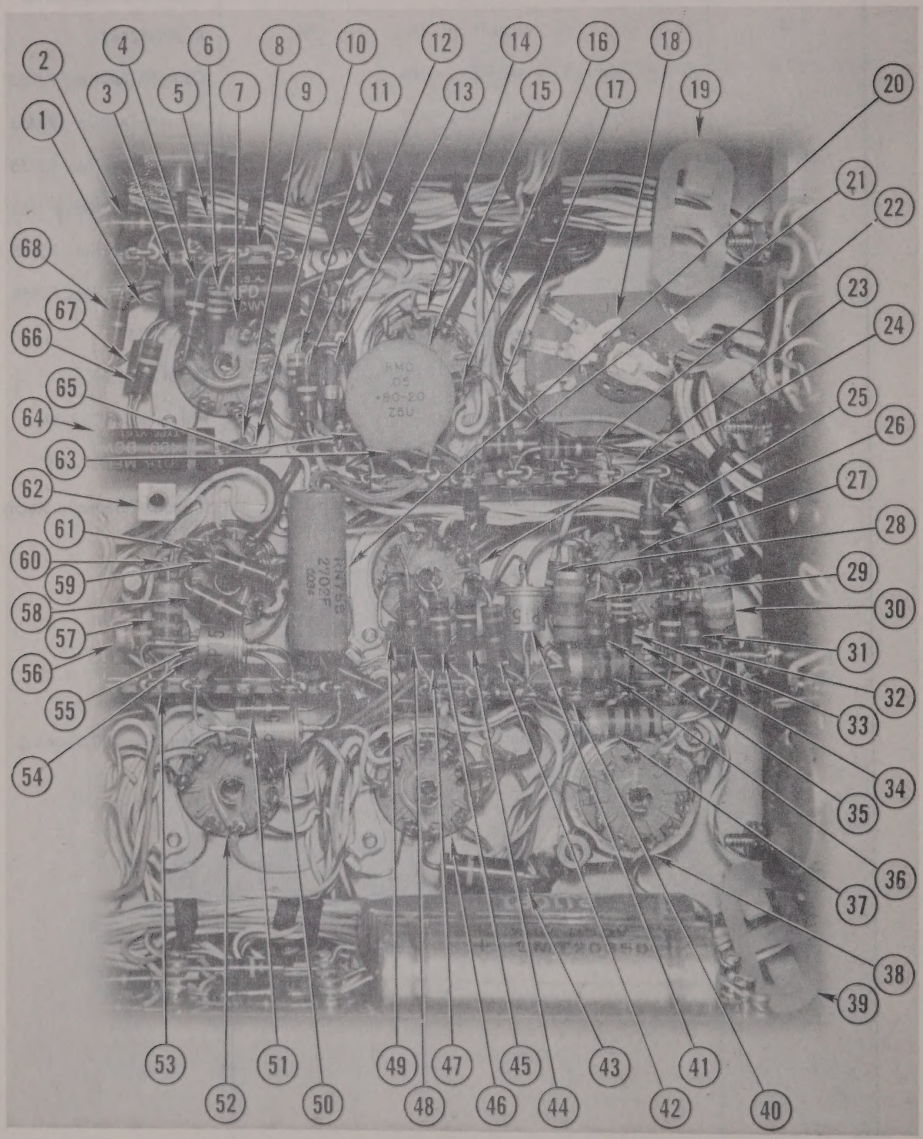

Figure 2-17. Transmitter Chassis, Right Half

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1		CHASSIS, Transmitter:	Radiation, D9037-390
2	R138	RESISTOR, fixed, composition: 10m, 1/2w, ±5%	RC20GF106J
3	C115	CAPACITOR, fixed, mylar: 0.015 mf, 400v, ±20%	Aerovox, V-161-81
4	R132	RESISTOR, fixed, composition: 220k, 1/2w, ±5%	RC20GF224J
5	R134	RESISTOR, fixed, composition: 10m, 1/2w, ±5%	RC20GF106J
6	R144	RESISTOR, fixed, composition: 330k, 1/2w, ±5%	RC20GF334J
7	V4	SOCKET, electron tube: 9-pin, miniature	Cinch, TS103P01
8	TP2 (tie point)	STRIP, terminal: XXXP, phenolic	Cinch, 2007
9	R143	RESISTOR, fixed, composition: 110k, 1/2w, ±5%	RC20GF114J
10	R142	RESISTOR, fixed, composition: 2.2m, 1/2w, ±5%	RC20GF225J
11	R141	RESISTOR, fixed, composition: 330k, 1/2w, ±5%	RC20GF334J
12	R140	RESISTOR, fixed, composition: 220k, 1/2w, ±5%	RC20GF224J
13	TP3 (tie point)	STRIP, terminal: XXXP, phenolic	Cinch, 2004
14	V5	SOCKET, electron tube: 9-pin, miniature	Cinch, TS103P01
15	C109	CAPACITOR, fixed, ceramic: 0.05 mf, -20%, +80%, 500v	Remler Company, B.05-3/4
16	R167	RESISTOR, fixed, composition: 220k, 1/2w, ±5%	RC20GF224J
17	R168	RESISTOR, fixed, composition: 1m, 1/2w, ±5%	RC20GF105J
18	S112	SWITCH, rotary:	See Figure 2-9
19		CLAMP, cable:	Dakota, 2C1-37B
20	R180	RESISTOR, fixed, deposited carbon: 27k, 1w, ±1%	Erie Resistor Corp., MDF
21	R173	RESISTOR, fixed, composition: 18m, 1/2w, ±5%	RC20GF186J
22	R169	RESISTOR, fixed, composition: 18m, 1/2w, ±5%	RC20GF186J
23	TP5 (tie point)	STRIP, terminal: XXXP, phenolic	Cinch, 2007
24	V15	SOCKET, electron tube: 9-pin, miniature	Cinch, TS103P01
25	R271	RESISTOR, fixed, composition: 100k, 1/2w, ±5%	RC20GF104J
26	C164	CAPACITOR, fixed, ceramic: 250 mmf, ±20%, 500v	Erie Resistor Corp., GP2K250
27	V14	SOCKET, electron tube: 9-pin, miniature	Cinch, TS103P01
28	R269	RESISTOR, fixed, composition: 270k, 1/2w, ±5%	RC20GF274J
29	C149	CAPACITOR, fixed, ceramic: 470 mmf, ±20%, 500v	Erie Resistor Corp., GP2K470
30	C153	CAPACITOR, fixed, ceramic: 470 mmf, ±20%, 500v	Erie Resistor Corp., GP2K470

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
31	R270	RESISTOR, fixed, composition: 1m, 1/2w, ±5%	RC20GF105J
32	R151	RESISTOR, fixed, composition: 100k, 1/2w, ±5%	RC20GF104J
33	R273	RESISTOR, fixed, composition: 39k, 1/2w, ±5%	RC20GF393J
34	R275	RESISTOR, fixed, composition: 270k, 1/2w, ±5%	RC20GF274J
35	R274	RESISTOR, fixed, composition: 1m, 1/2w, ±5%	RC20GF105J
36	C150	CAPACITOR, fixed, ceramic: 100 mmf, ±20%, 500v	Erie Resistor Corp., GP1K100
37	C152	CAPACITOR, fixed, ceramic: 100 mmf, ±20%, 500v	Erie Resistor Corp., GP1K100
38	RL1	SOCKET: 9-pin, miniature	Cinch, 9EM
39		CLAMP, cable:	Dakota, 2C1-37B
40	TP9 (tie point)	STRIP, terminal: XXXP, phenolic	Cinch, 2007
41	CR127	DIODE:	Radio Receptor, PT5
42	R276	RESISTOR, fixed, composition: 6.8m, 1/2w, ±5%	RC20GF685J
43	R261	RESISTOR, fixed, composition: 15k, 2w, ±5%	RC32GF153J
44	R277	RESISTOR, fixed, composition: 100k, 1/2w, ±5%	RC20GF104J
45	R278	RESISTOR, fixed, composition: 100k, 1/2w, ±5%	RC20GF104J
46	V10	SOCKET, electron tube: 9-pin, miniature	Cinch, TS103P01
47	R280	RESISTOR, fixed, composition: 470k, 1/2w, ±5%	RC20GF474J
48	R284	RESISTOR, fixed, composition: 1m, 1/2w, 5%	RC20GF105J
49	R279	RESISTOR, fixed, composition: 1m, 1/2w, 5%	RC20GF105J
50	CR105	DIODE:	Radio Receptor, PT5
51	R121	RESISTOR, fixed, composition: 10m, 1/2w, ±5%	RC20GF106J
52	V11	SOCKET, electron tube: 9-pin, miniature	Cinch, TS103P01
53	TP8 (tie point)	STRIP, terminal: XXXP, phenolic	Cinch, 2007
54	R120	RESISTOR, fixed, composition: 10m, 1/2w, ±5%	RC20GF106J
55	CR104	DIODE:	Radio Receptor, PT5
56	C107	CAPACITOR, fixed, ceramic: 150 mmf, ±20%, 500v	Erie Resistor Corp., GP2K150
57	C106	CAPACITOR, fixed, ceramic: 150 mmf, ±20%, 500v	Erie Resistor Corp., GP2K150
58	R179	RESISTOR, fixed, ceramic: 1m, 1/2w, ±5%	RC20GF105J
59	R181	RESISTOR, fixed, ceramic: 1m, 1/2w, ±5%	RC20GF105J
60	R177	RESISTOR, fixed, composition: 330k, 1/2w, ±5%	RC20GF334J

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
61	V6	SOCKET, electron tube: 9-pin, miniature	Cinch, TS103P01
62		SPACER, terminal board lock:	Radiation, D9037-321
63	R174	RESISTOR, fixed, composition: 1m, 1/2w, ±5%	RC20GF105J
64	C112	CAPACITOR, fixed, mylar: 0.015 mf, ±20%, 400v	Aerovox, V-161-81
65	R175	RESISTOR, fixed, composition: 220k, 1/2w, ±5%	RC20GF224J
66	R145	RESISTOR, fixed, composition: 2.2m, 1/2w, ±5%	RC20GF225J
67	R146	RESISTOR, fixed, composition: 110k, 1/2w, ±5%	RC20GF114J
68	R133	RESISTOR, fixed, composition: 1m, 1/2w, ±5%	RC20GF105J

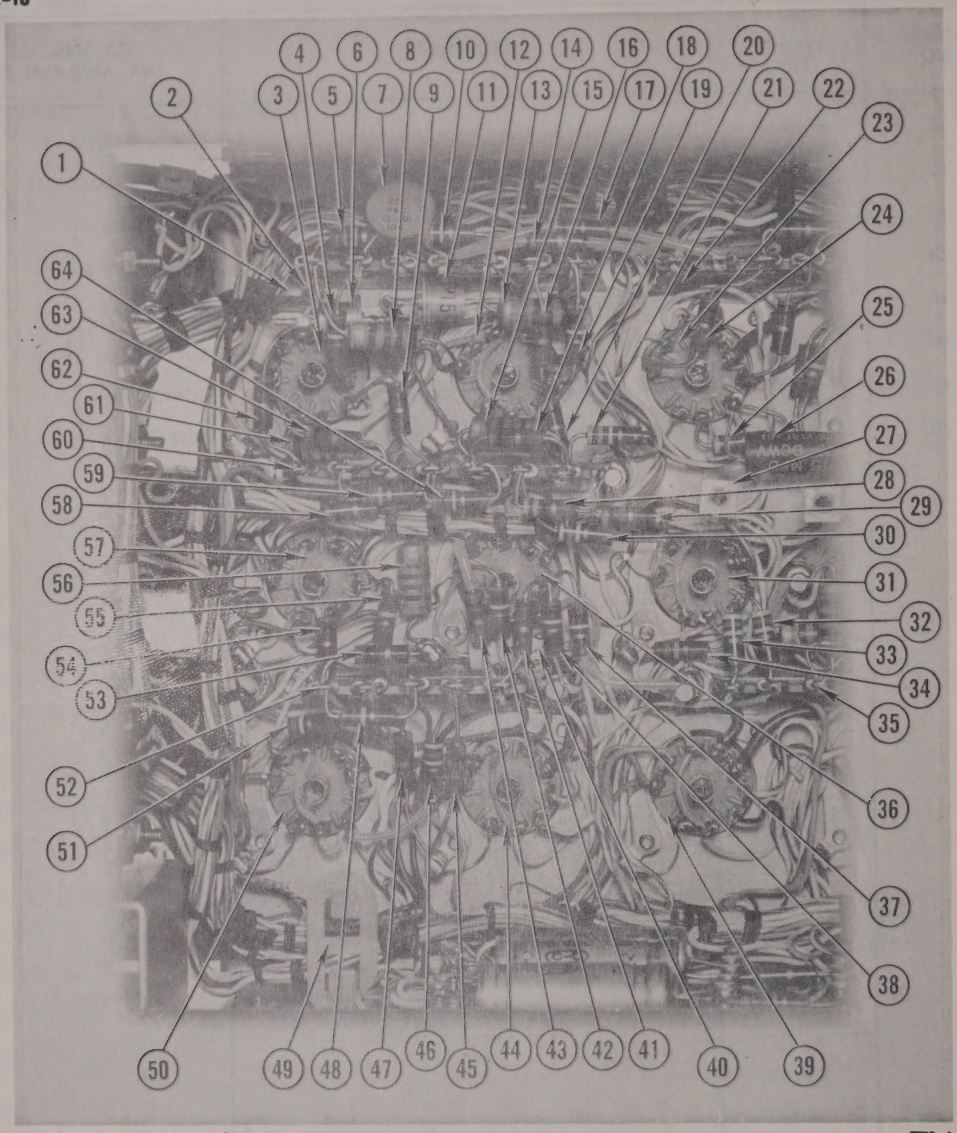

Figure 2-18. Transmitter Chassis, Left Half

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1		CHASSIS, Transmitter:	Radiation, D9037-390
2	TP1 (tie point)	STRIP, terminal: XXXP, phenolic	Cinch, 2007
3	V1	SOCKET, electron tube: 9-pin, miniature	Cinch, TS103P01

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
4	R124	RESISTOR, fixed, composition: 1/2w, 100k, ±5%	RC20GF104J
5	R112	RESISTOR, fixed, composition: 130k, 1/2w, ±5%	RC20GF134J
6	CR102	DIODE:	Radio Receptor, PT5
7	C158	CAPACITOR, fixed, ceramic: 0.001 mf, 1000v, ±10%	Remler Company, JL.001-1/2
8	C103	CAPACITOR, fixed, ceramic: 150 mmf, 500v, ±20%	Erie Resistor Corp., GP2K150
9	R123	RESISTOR, fixed, composition: 1.2m, 1/2w, ±5%	RC20GF125J
10	R119	RESISTOR, fixed, composition: 130k, 1/2w, ±5%	RC20GF134J
11	CR103	DIODE:	Radio Receptor, PT5
12	V2	SOCKET, electron tube: 9-pin, miniature	Cinch, TS103P01
13	C105	CAPACITOR, fixed, ceramic: 150 mmf, 500v, ±20%	Erie Resistor Corp., GP2K150
14	R291	RESISTOR, fixed, composition: 1m, 1/2w, ±5%	RC20GF105J
15	C104	CAPACITOR, fixed, ceramic: 100 mmf, 500v, ±20%	Erie Resistor Corp., GP1K100
16	R109	RESISTOR, fixed, composition: 1m, 1/2w, ±5%	RC20GF105J
17	R292	RESISTOR, fixed, composition: 100k, 1/2w, ±5%	RC20GF104J
18	R114	RESISTOR, fixed, composition: 1m, 1/2w, ±5%	RC20GF105J
19	R118	RESISTOR, fixed, composition: 100k, 1/2w, ±5%	RC20GF104J
20	R115	RESISTOR, fixed, composition: 1m, 1/2w, ±5%	RC20GF105J
21	R116	RESISTOR, fixed, composition: 330k, 1/2w, ±5%	RC20GF334J
22	TP2 (tie point)	STRIP, terminal: XXXP, phenolic	Cinch, 2007
23	V3	SOCKET, electron tube: 9-pin, miniature	Cinch, TS103P01
24	R139	RESISTOR, fixed, composition: 1m, 1/2w, ±5%	RC20GF105J
25	R126	RESISTOR, fixed, composition: 3.3m, 1/2w, ±5%	RC20GF335J
26	C112	CAPACITOR, fixed, mylar: 0.015 mf, 400v, ±20%	Aerovox, V-161-81
27		SPACER, terminal board lock:	Radiation, D9037-321
28	R201	RESISTOR, fixed, composition: 3.3m, 1/2w, ±5%	RC20GF335J
29	R204	RESISTOR, fixed, composition: 15m, 1/2w, ±5%	RC20GF156J
30	R202	RESISTOR, fixed, composition: 470k, 1/2w, ±5%	RC20GF474J
31		SOCKET, electron tube: 9-pin, miniature	Cinch, TS103P01
32	R197	RESISTOR, fixed, composition: 470k, 1/2w, ±5%	RC20GF474J
33	R195	RESISTOR, fixed, composition: 470k, 1/2w, ±5%	RC20GF474J
34	R193	RESISTOR, fixed, composition: 27k, 1/2w, ±5%	RC20GF273J

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
35	TP8 (tie point)	STRIP, terminal: XXXP, phenolic	Cinch, 2007
36	V8	SOCKET, electron tube: 9-pin, miniature	Cinch, TS103P01
37	R210	RESISTOR, fixed, composition: 100k, 1/2w, 5%	RC20GE104J
38	R209	RESISTOR, fixed, composition: 100k, 1/2w, 5%	RC20GF104J
39	V12	SOCKET, electron tube: 9-pin, miniature	Cinch, TS103P01
40	C133	CAPACITOR, fixed, mylar: 0.01 mf, 400v, ±5%	Plastic Capacitor, LT4-103
41	R208	RESISTOR, fixed, composition: 2.2m, 1/2w, ±5%	RC20GF225J
42	R212	RESISTOR, fixed, composition: 100k, 1/2w, ±5%	RC20GF104J
43	R206	RESISTOR, fixed, composition: 1m, 1/2w, 5%	RC20GF105J
44	V13	SOCKET, electron tube: 9-pin, miniature	Cinch, TS103P01
45	R295	RESISTOR, fixed, composition: 1m, 1/2w, ±5%	RC20GF105J
46	R296	RESISTOR, fixed, composition: 470k, 1/2w, ±5%	RC20GF474J
47	R294	RESISTOR, fixed, composition: 1m, 1/2w, ±5%	RC20GF105J
48	R217	RESISTOR, fixed, composition: 680k, 1/2w, ±5%	RC20GF684J
49		CLAMP, cable:	Dakota, 2C1-37B
50	V16	SOCKET, electron tube: 9-pin, miniature	Cinch, TS103P01
51	R293	RESISTOR, fixed, composition: 470k, 1/2w, ±5%	RC20GF474J
52	TP7 (tie point)	STRIP, terminal: XXXP, phenolic	Cinch, 2005
53	R216	RESISTOR, fixed, composition: 1m, 1/2w, ±5%	RC20GF105J
54	R215	RESISTOR, fixed, composition: 1m, 1/2w, ±5%	RC20GF105J
55	R218	RESISTOR, fixed, composition: 220k, 1/2w, ±5%	RC20GF224J
56	C130	CAPACITOR, fixed, ceramic: 250 mmf, 200v, 20%	Erie Resistor Corp., GP2K250
57	V9	SOCKET, electron tube: 9-pin, miniature	Cinch, TS103P01
58	R219	RESISTOR, fixed, composition: 1m, 1/2w, ±5%	RC20GF105J
59	R125	RESISTOR, fixed, composition: 12k, 1/2w, ±5%	RC20GF123J
60	TP6 (tie point)	STRIP, terminal: XXXP, phenolic	Cinch, 2007
61	C102	CAPACITOR, fixed, ceramic: 100 mmf, 500v, ±20%	Erie Resistor Corp., GP1K100
62	R108	RESISTOR, fixed, composition: 1m, 1/2w, ±5%	RC20GF105J
63	R110	RESISTOR, fixed, composition: 1m, 1/2w, 5%	RC20GF105J
64	R113	RESISTOR, fixed, composition: 100k, 1/2w, ±5%	RC20GF104J

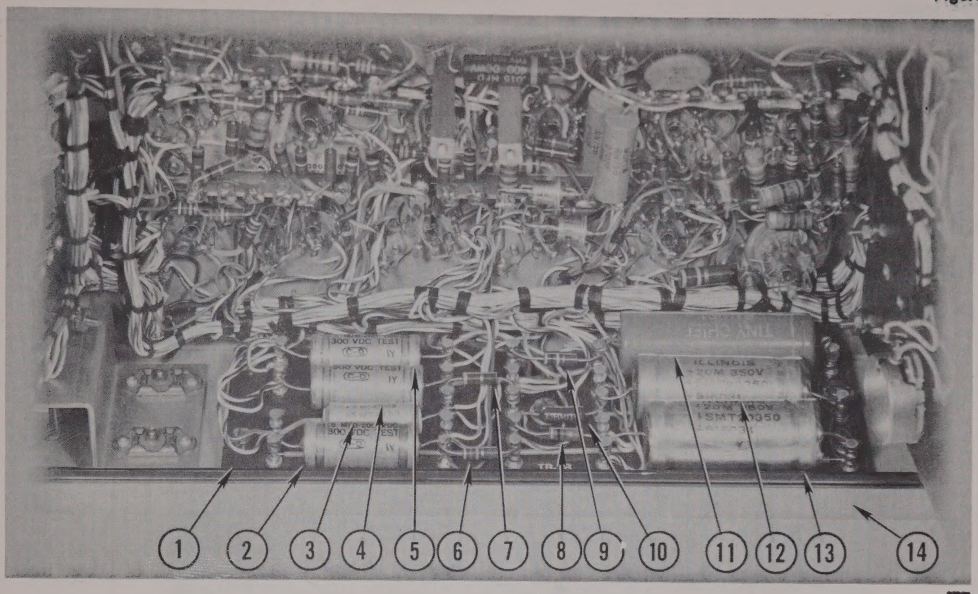

Figure 2-19. Transmitter Terminal Board, TB18

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1	TB18	BOARD, terminal:	Radiation, C9037-906
2	C157	CAPACITOR, fixed, paper: 5 mf, ±20%, 200v	Cornell-Dubilier, MTM-2-P5
3	C160	CAPACITOR, fixed, electrolytic: 4 mf, -10%, +50%, 250v	Illinois Conductor Corp., SMT4250
4	C159	CAPACITOR, fixed, paper: 0.5 mf, ±20%, 200v	Cornell-Dubilier, MTM-2-P5
5	C154	CAPACITOR, fixed, paper: 0.5 mf, ±20%, 200v	Cornell-Dubilier, MTM-2-P5
6	R286	RESISTOR, fixed, composition: 68k, ±5%, 1/2w	RC20GF683J
7	R302	RESISTOR, fixed, composition: 8.2k, ±5%, 1/2w	RC20GF822J
8	R303	RESISTOR, fixed, composition: 1k, ±5%, 1/2w	RC20GF102J
9	R305	RESISTOR, fixed, composition: 100k, ±5%, 1/2w	RC20GF104J
10	R304	RESISTOR, fixed, wire wound:	Radiation, A9037-1302
11	C163	CAPACITOR, fixed, paper: 0.1 mf, ±20%, 1000v	Cornell-Dubilier, PJ-10-P2
12	C162	CAPACITOR, fixed, electrolytic: 20 mf, -10%, +50%, 250v	Illinois Conductor Corp., SMT4250
13	C161	CAPACITOR, fixed, electrolytic: 20 mf, -10%, +50%, 350v	Illinois Conductor Corp., SMT20350
14		COVER, bottom:	Radiation, D9037-1310-2

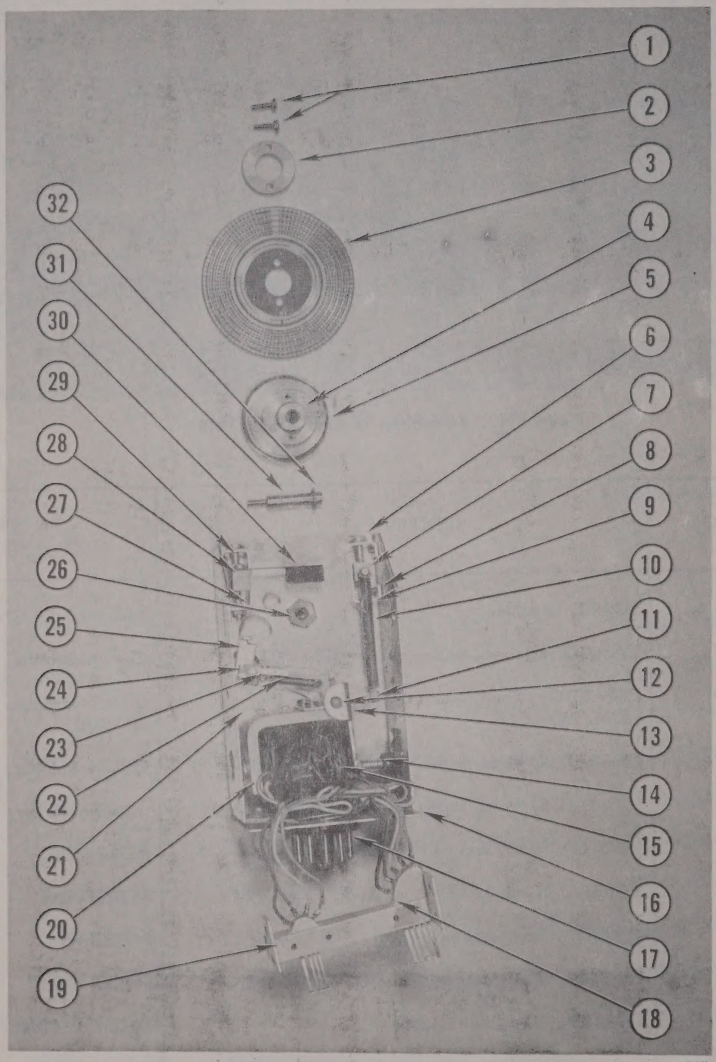

Figure 2-20. Transmitter Coder Disassembled

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1		SCREW: 2-56, NC2A x 5/16 lg., ph cres	MS352333-4
2		DISC, retaining:	Radiation, A9037-1216
3		DISC, coder:	Radiation, D9037-1230-3
4		HUB:	Radiation, B9037-1220-1
5		WHEEL, indexing:	Radiation, A9037-1214-1
6		SCREW, adjustment: 4-40, NC2A x 1" long, ph cres	MS35233
7		BLOCK, spring:	Radiation, A9037-1224-1
8		BRACKET:	Radiation, B9037-1225-1
9		NUT, hex:	Erna, 68-1660-40
10		SPRING, armature return:	Radiation, A9037-1227
11		ARMATURE:	Radiation, A9037-1235
12		HINGE, pin:	Radiation, A9037-1247-1
13		HINGE:	Radiation, A9037-1247
14		SCREW, adjustment:	AN565DC-632410
15	L1	COIL:	Radiation, B9037-1203F
16		PLATE, base:	Radiation, B9037-1249-G1
17		CONNECTOR: 11-pin, retaining ring	Amphenol, 86-CP11
18		CONTACT HOLDER:	Radiation, B9037-1234-G1
19		BRIDGE: BRIDGE, plate:	Radiation, A9037-1222-1 Radiation, A9037-1221-1
20		HEEL:	Radiation, A9037-219-1
21		FRAME:	Radiation, C9037-1229-G1
22		SPRING, pawl, return:	Radiation, A9037-1244-1
23		PIN, cotter:	AN381-15-5
24		SCREW, pawl:	Radiation, A9037-1245-1
25		PLATE, pawl, stop:	Radiation, A9037-1246-1
26		NUT, centering:	Radiation, 9037-1233-1
27		BRACKET:	Radiation, B9037-1225-1
28		BLOCK, brake:	Radiation, A9037-1224-1
29		SCREW, adjustment: 4-40, NC2A x 1/8 long, cres	MS35233-21
30		BRAKE ARM:	Radiation, B9037-1226-G1
31		SPINDLE:	Radiation, A9037-1215-1
32		RING, retaining:	Truarc, 5133-18

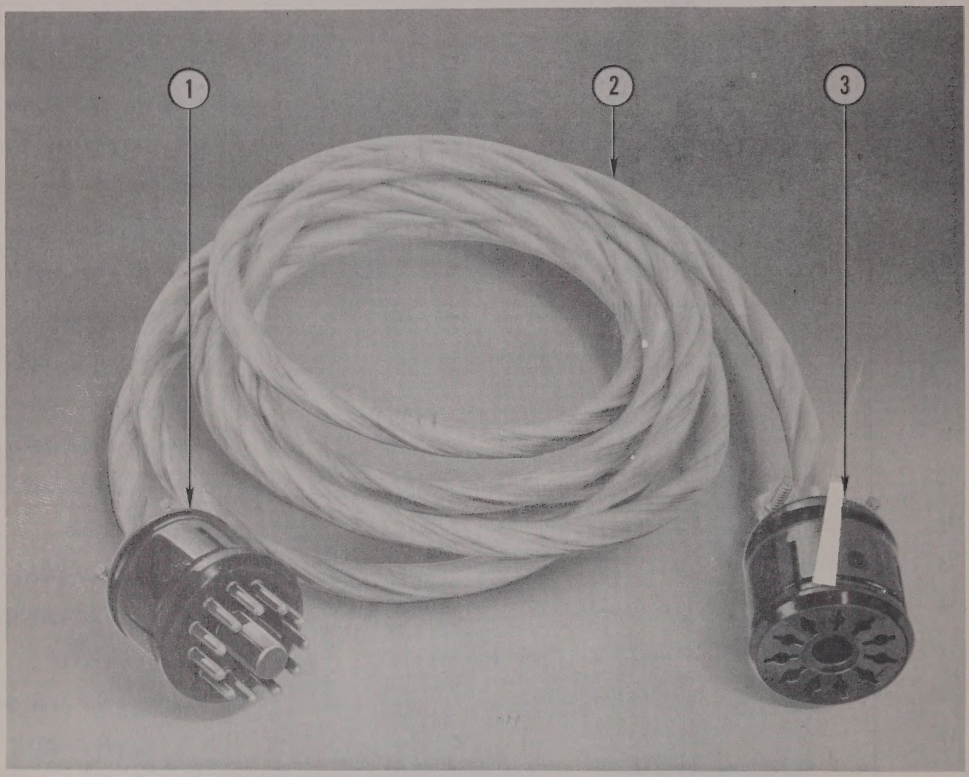

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Figure 2-21. Transmitter Code Adapter Cable

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1		PLUG, with hood: 11-pin	Amphenol, 86PM-11-11
2		CABLE, coder:	Radiation, 9705-A9
3		RECEPTACLE, with hood: 11-pin	Amphenol, 78PF11-11

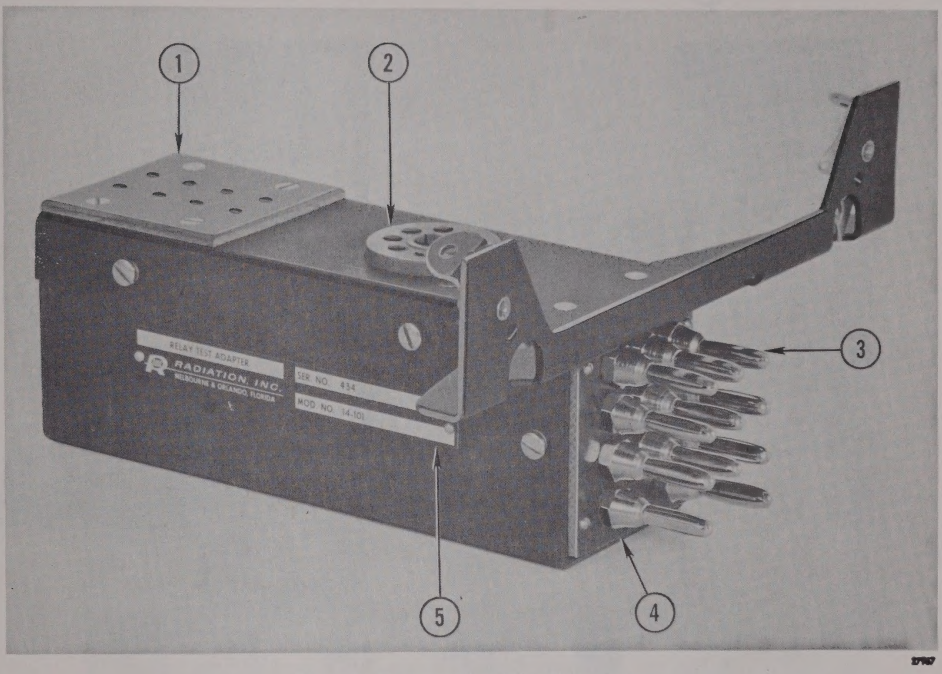

Figure 2-22. Transmitter Relay Test Adapter

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1		INSULATOR, relay:	Radiation, 9037-383
2		SOCKET, octal:	TS101P01
3		PLUG, banana, with hardware:	Federal, #435
4		BOARD, insulating:	Radiation, 9037-366
5		PLATE, identification:	Radiation, 9037-714-3

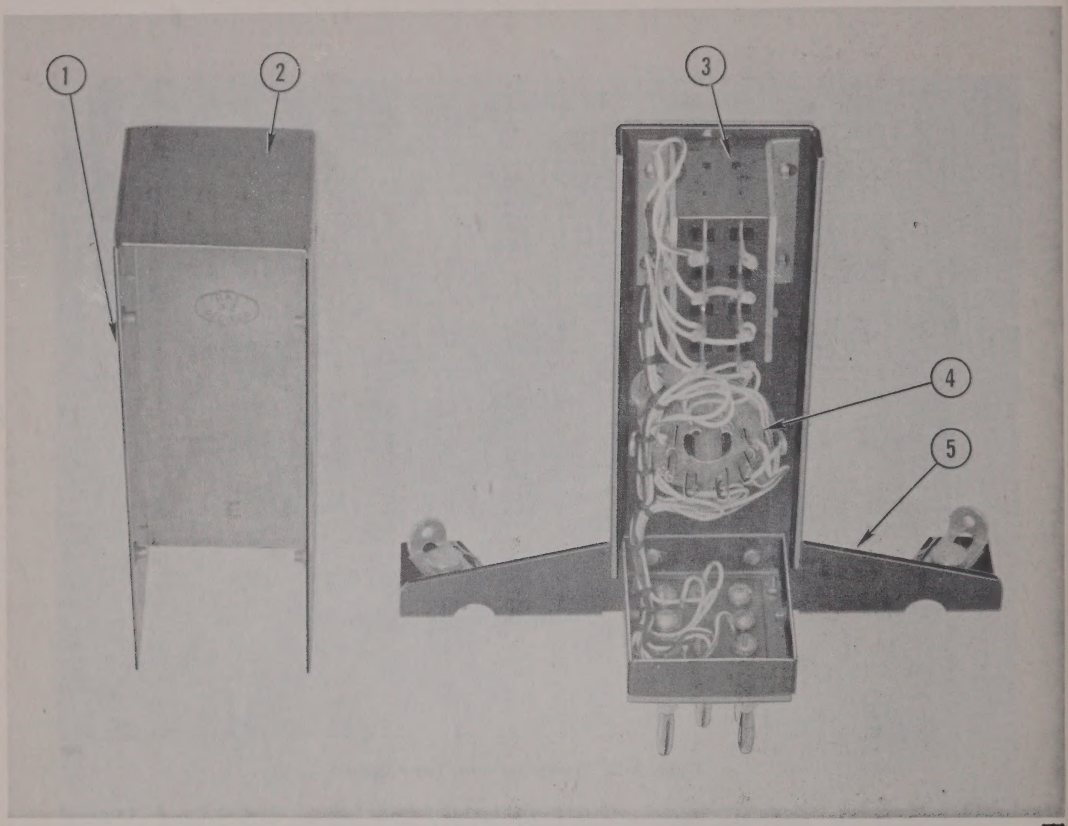

Figure 2-23. Transmitter Relay Test Adapter, Cover Removed

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1		NAMEPLATE, Federal:	Radiation, C9037-797-27
2		COVER, Relay Test Adapter:	Radiation, B9037-362
3		JACK (modified):	Radiation, 9037-360
4		SOCKET, octal:	Cinch, TS101P01
5		BRACKET, mounting:	Radiation, C9037-364

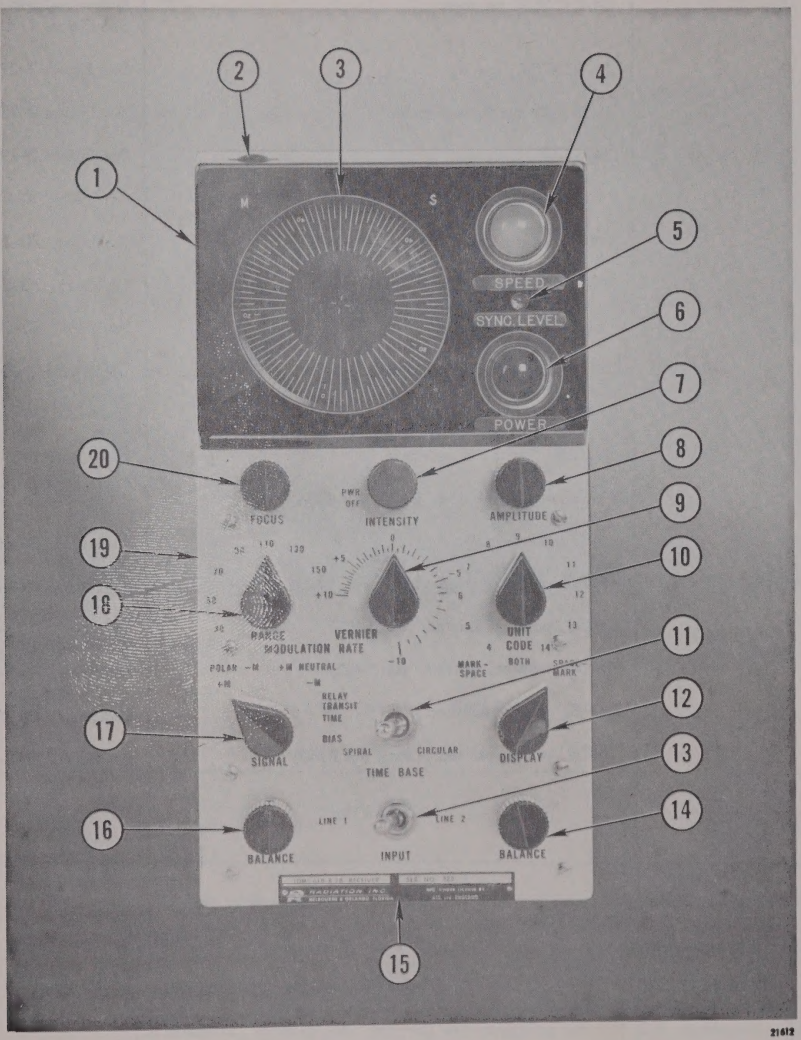

Figure 2-24. Receiver, Front Panel

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1		BEZEL, molded:	Radiation, 500287
2		INDEX WHEEL:	Radiation, 400392 See Figure 2-32
3		GRATICULE, receiver:	Radiation, B9037-396 See Figure 2-32
4	I2	INDICATOR, speed:	See Figure 2-29
5	R570	RESISTOR: sync level control	See Figure 2-29
6	I1	INDICATOR, power:	See Figure 2-29
7		KNOB, round, skirted: red (for S401/R546)	Raytheon, 70-2-2
8		KNOB, round, skirted: black (for R465)	Raytheon, 70-2-2
9		KNOB, pointer, skirted: (for R453)	Raytheon, 70-5-2
10		KNOB, pointer, skirted: (for S406)	Raytheon, 70-5-2
11	S404	SWITCH: time base selector	See Figure 2-29
12		KNOB, pointer, skirted: (for S407)	Raytheon, 70-5-2
13	S408	SWITCH: input line selector	See Figure 2-29
14		KNOB, round, skirted: black (for R406)	Raytheon, 70-2-2
15		PLATE, identification:	Radiation, B9037-710
16		KNOB, round, skirted: black (for R405)	Raytheon, 70-2-2
17		KNOB, pointer, skirted: (for S403)	Raytheon, 70-5-2
18		KNOB, pointer, skirted: (for S402)	Raytheon, 70-5-2
19		PANEL, front, receiver:	Radiation, D9037-121-1
20		KNOB, round, skirted: black (for R550)	Raytheon, 70-2-2

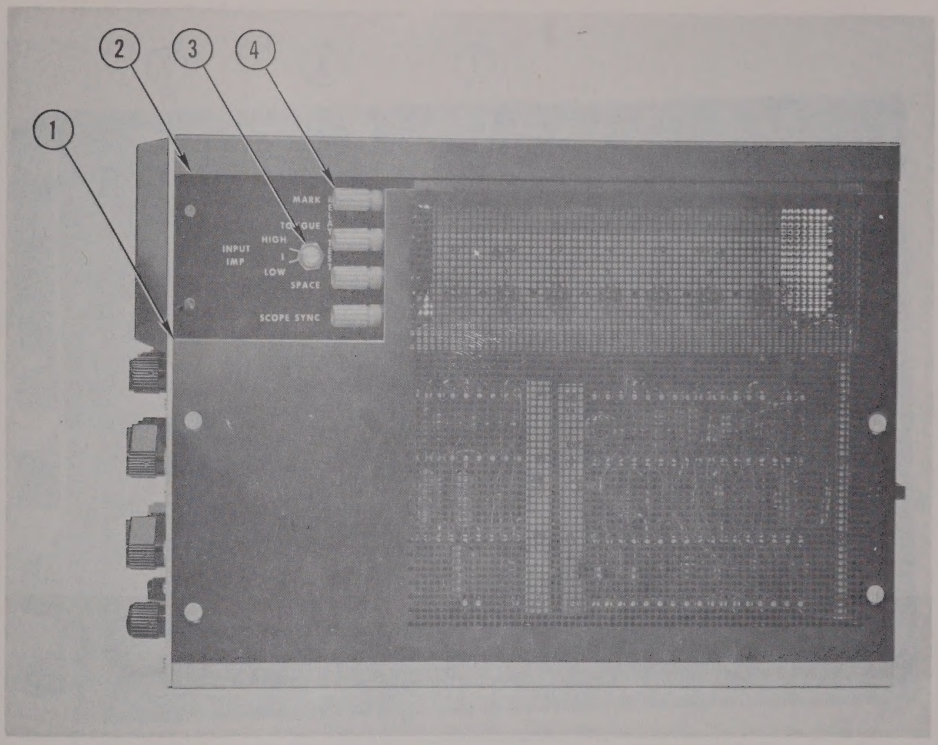

Figure 2-25. Receiver, Right Side

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1		COVER: right side	Radiation, D9037-329-1
2		BRACKET, binding post: right side	Radiation, 9037-323-1
3	S409	SWITCH: input impedance selector	See Figure 2-43
4		TERMINAL, binding post: (4) red, with mounting nut	E.F. Johnson Co., 111-102

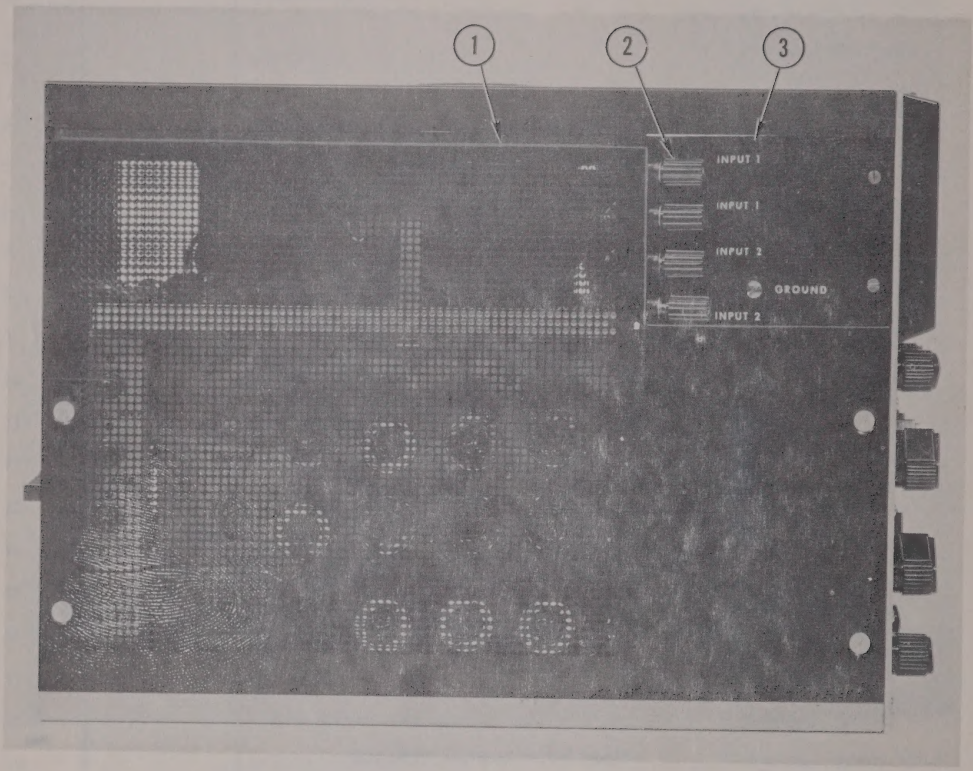

Figure 2-26. Receiver, Left Side

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1		COVER: left side	Radiation, D9037-329-2
2		TERMINAL, binding post: (4), black, with mounting nut	E.F. Johnson Co., 111-103
3		BRACKET, binding post: left side	Radiation, 9037-326-1

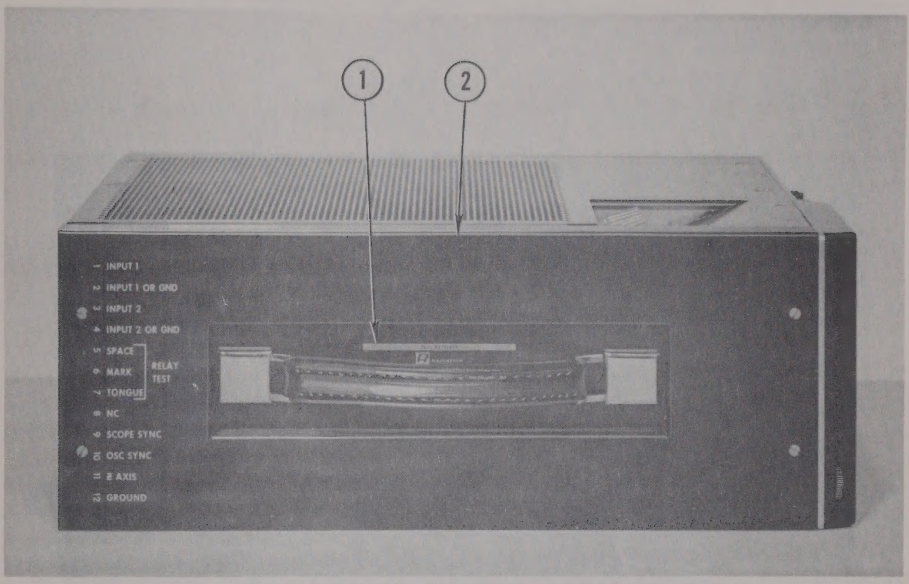

Figure 2-27. Receiver, Top View

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1		PLATE, identification:	Radiation, 9037-797
2		COVER: top, receiver	Radiation, 9037-341-1

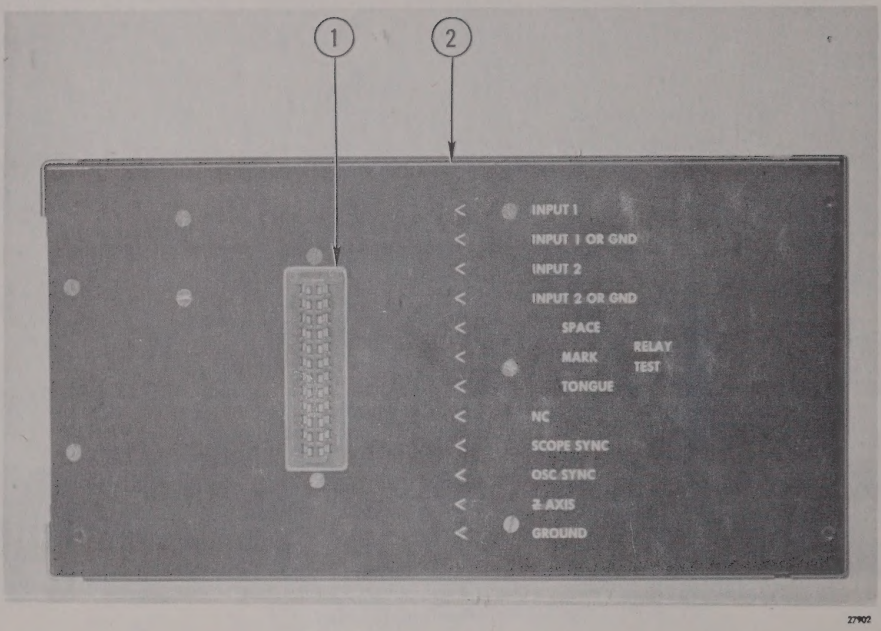

Figure 2-28. Receiver, Rear View

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1		CONNECTOR:	Amphenol, 26-4100-24P
2		COVER: rear, receiver	Radiation, 9037-336-2

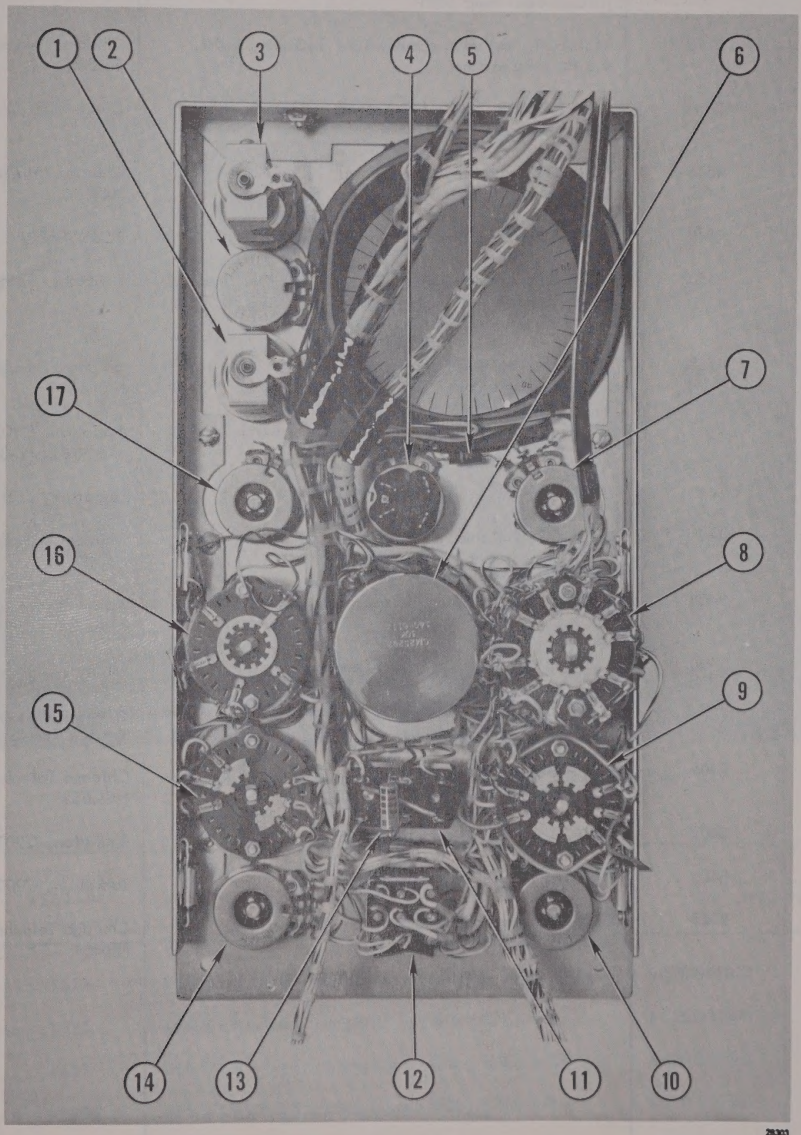

Figure 2-29. Receiver Front Panel, Interior View

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1	I1	LAMPHOLDER: red lens, power indicator, includes incandescent lamp 1891	Drake Mfg. Co., 260-1-1L
2	R570	RESISTOR, variable, composition: 1.0 meg, ±10%, 0.5 in. slotted shaft	Chicago Telephone Supply, FR6646
3	I2	LAMPHOLDER: white lens, speed indicator, includes neon glow lamp NE-51	Drake Mfg. Co., 660-1-1L
4	R546-S401	RESISTOR, variable, composition: 100k, ±20%, 0.75 in. round shaft, includes dpst switch	Chicago Telephone Supply, HR4102
5	R549	RESISTOR, fixed, composition: 120k, ±5%, 1/2w	RC20GF124J
6	R453	RESISTOR, variable, wire wound: 30k, ±1%, linear taper, linearity tol. ±2%, phasing tol. ±30%, 0.75 in. shaft from housing, bushing 3/8 in. lg.	Clarostat, 58 dual
7	R550	RESISTOR, variable, composition: 250k, ±10%, 0.75 in. round shaft	Chicago Telephone Supply, HQ3634
8	S402	SWITCH, rotary: modulation rate range switch	Radiation, C9037-115 See Figures 2-30 and 2-31
9	S403	SWITCH, rotary: signal selector	Radiation, C9037-124
10	R405	RESISTOR, variable, composition: 1.0 meg, ±10%, 0.75 in. round shaft	Chicago Telephone Supply, HQ3635
11	S404	SWITCH, toggle: dpdt, includes mounting hardware	Arrow Hart and Hegeman, 81027CE
12	S408	SWITCH, toggle: 3 pdt, includes mounting hardware	Micro-Switch, 6AT10
13	C411	CAPACITOR, fixed, ceramic: 250 mmf, ±20%, 500 vdcw	Erie Resistor Corp., GP2K250±20%
14	R406	RESISTOR, variable, composition: 1.0 meg, ±10%, 0.75 in. round shaft	Chicago Telephone Supply, HQ3635
15	S407	SWITCH, rotary: display selector	Radiation, C9037-104
16	S406	SWITCH, rotary: unit code selector	Radiation, C9037-103
17	R465	RESISTOR, variable, composition: 1.0k, ±10%, 0.75 in. round shaft	Chicago Telephone Supply, FR6651

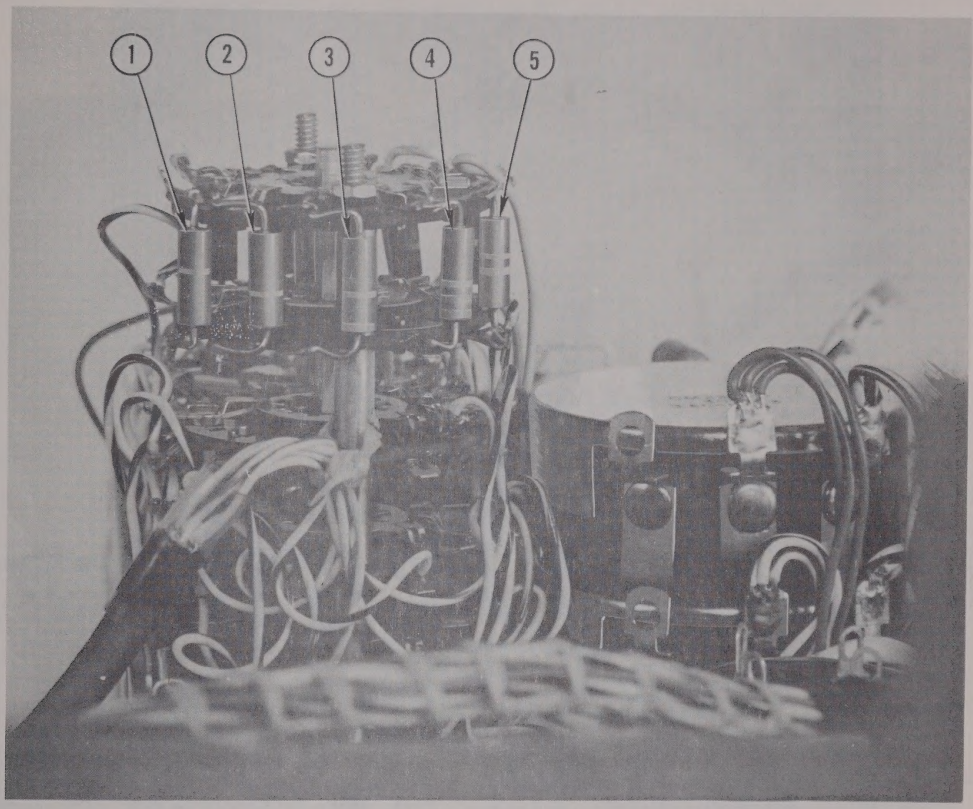

Figure 2-30. Receiver Modulation Rate Range Switch, S402, Top View

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1	R623	RESISTOR, fixed, composition: 1.0 meg, ±5%, 1/2w	RC20GF105J
2	R622	RESISTOR, fixed, composition: 560k, ±5%, 1/2w	RC20GF564J
3	R621	RESISTOR, fixed, composition: 470k, ±5%, 1/2w	RC20GF474J
4	R620	RESISTOR, fixed, composition: 330k, ±5%, 1/2w	RC20GF334J
5	R619	RESISTOR, fixed, composition: 220k, ±5%, 1/2w	RC20GF224J

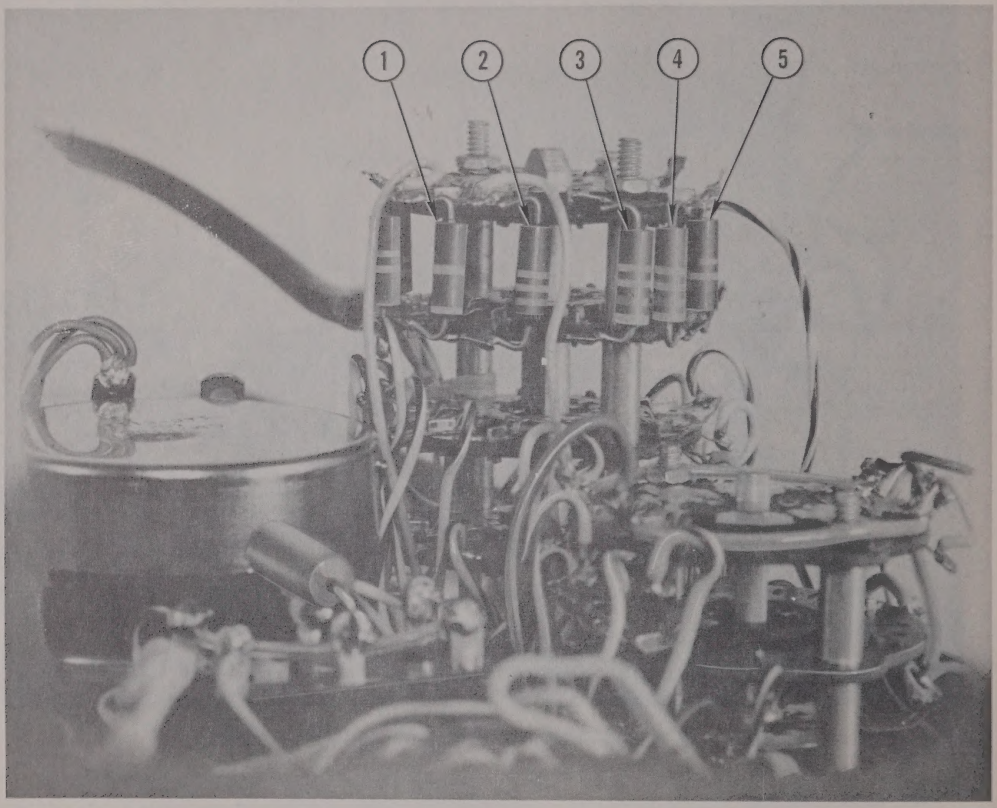

Figure 2-31. Receiver Modulation Rate Range Switch, S402, Bottom View

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1	R618	RESISTOR, fixed, composition: 1.0 meg, ±5%, 1/2w	RC20GF105J
2	R617	RESISTOR, fixed, composition: 560k, ±5%, 1/2w	RC20GF564J
3	R616	RESISTOR, fixed, composition: 470k, ±5%, 1/2w	RC20GF474J
4	R615	RESISTOR, fixed, composition: 330k, ±5%, 1/2w	RC20GF334J
5	R614	RESISTOR, fixed, composition: 220k, ±5%, 1/2w	RC20GF224J

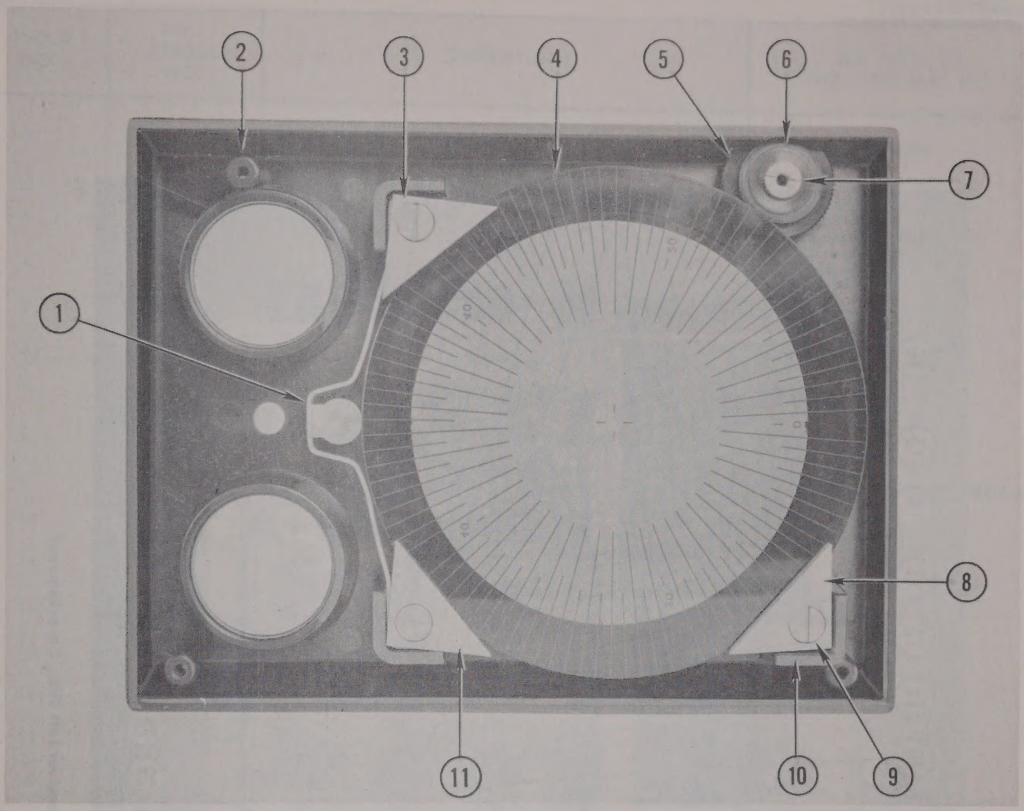

Figure 2-32. Receiver Front Panel Bezel, Interior View

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1		IDLER, roller:	Radiation, 350154-1
2		BEZEL, molded:	Radiation, 500287
3		RETAINER, graticule:	Radiation, A9037-395
4		GRATICULE, engraved:	Radiation, B9037-396
5		INDEX WHEEL:	Radiation, 400392
6		SEAL, O ring: 0.362 in. ID x 0.568 in. OD x 0.103 in. thick	Parker #110
7		STUD, locking:	Radiation, 300289
8		RETAINER, graticule:	Radiation, A9037-395
9		SCREW, graticule retainer: (3)	Radiation, A9037-394
10		ROLLER, graticule mounting:	Radiation, A9037-393-1
11		RETAINER, graticule:	Radiation, A9037-395

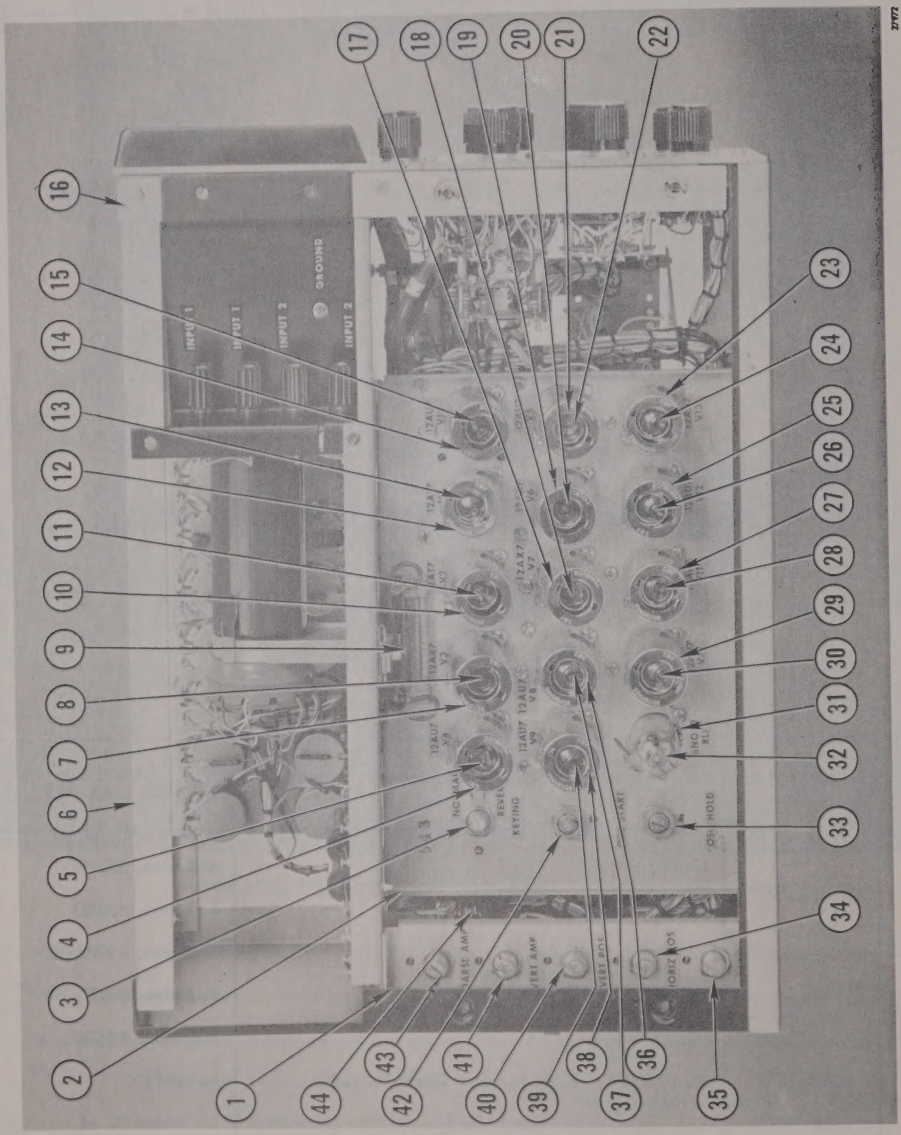

Figure 2-33. Receiver Left Side, Cover Removed

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1		BRACKET, rear, potentiometer:	Radiation, 9037-359
2		CHASSIS, receiver:	Radiation, D9037-132
3	S410	SWITCH, rotary:	Radiation, 9037-305
4		TUBE SHIELD: 9-pin	Cinch, TS103U02
5	V4	TUBE, electron:	12AU7
6		BRACE: top support, left side	Radiation, C9037-110
7		TUBE SHIELD: 9-pin	Cinch, TS103U02
8	V3	TUBE, electron:	12AX7
9		RELAY, thermal: surgistor	Wurth Tube Saver Corp., 4002-5
10		TUBE SHIELD: 9-pin	Cinch, TS103U02
11	V2	TUBE, electron:	12AT7
12		TUBE SHIELD: 9-pin	Cinch, TS103U02
13	V1	TUBE, electron:	12AT7
14		TUBE SHIELD: 9-pin	Cinch, TS103U02
15	V14	TUBE, electron:	12AU7
16		PANEL LIP, front, receiver:	Radiation, D9037-322-1
17		TUBE SHIELD: 9-pin	Cinch, TS103U02
18	V7	TUBE, electron:	12AX7
19		TUBE SHIELD: 9-pin	Cinch, TS103U02
20	V6	TUBE, electron:	12AX7
21		TUBE SHIELD: 9-pin	Cinch, TS103U02
22	V5	TUBE, electron:	12AU7
23		TUBE SHIELD: 9-pin	Cinch, TS103U02
24	V13	TUBE, electron:	12AU7
25		TUBE SHIELD: 9-pin	Cinch, TS103U02
26	V12	TUBE, electron:	12AU7
27		TUBE SHIELD: 9-pin	Cinch, TS103U02
28	V11	TUBE, electron:	12AU7
29		TUBE SHIELD: 9-pin	Cinch, TS103U02
30	V10	TUBE, electron:	12AU7

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
31		CLIP, tube:	Remler, W73819
32		RELAY, thermal:	Amperite, CW030T
33	R436	RESISTOR, variable, composition: 500k, ±10%, slotted shaft 0.5 in. lg., 3/8 in. bushing	Chicago Telephone Supply, FR6641
34	R473	RESISTOR, variable, composition: 1.0 meg, ±10%, slotted shaft 0.5 in. lg., 3/8 in. bushing	Chicago Telephone Supply, FR6646
35	R574	RESISTOR, variable, composition: 1.0 meg, ±10%, slotted shaft 0.5 in. lg., 3/8 in. bushing	Chicago Telephone Supply, FR6646
36		TUBE SHIELD: 9-pin	Cinch, TS103U02
37	V8	TUBE, electron:	12AU7
38		TUBE SHIELD: 9-pin	Cinch, TS103U02
39	V9	TUBE, electron:	12AU7
40	R485	RESISTOR, variable, composition: 1.0 meg, ±10%, slotted shaft 0.5 in. lg., 3/8 in. bushing	Chicago Telephone Supply, FR6646
41	R480	RESISTOR, variable, composition: 5k, ±10%, slotted shaft 0.5 in. lg., 3/8 in. bushing	Chicago Telephone Supply, FR6645
42	R434	RESISTOR, variable, composition: 500k, ±10%, slotted shaft 0.5 in. lg., 3/8 in. bushing	Chicago Telephone Supply, FR6641
43	R467	RESISTOR, variable, composition: 10k, ±10%	Chicago Telephone Supply, HF1544
44		RELAY: 6.3vdc, 4 pst	Aemco, 83-3939

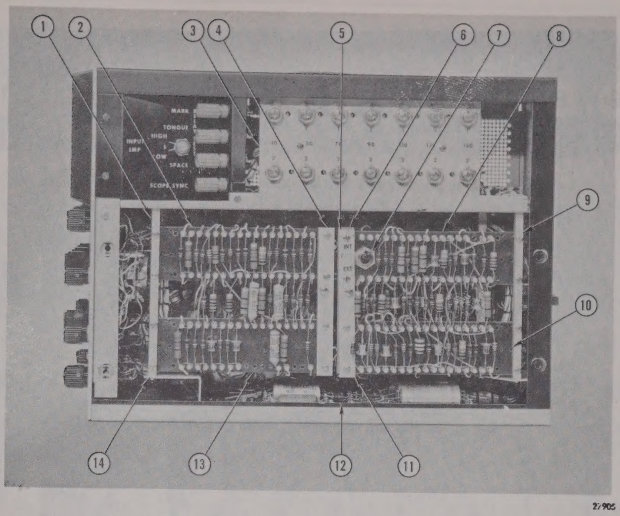

Figure 2-34. Receiver Right Side, Cover Removed

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1		"A" DOOR: Includes TB21 and TB22	
2	TB21	TERMINAL BOARD:	Radiation, B9037-844 See Figure 2-36
3		BRACKET, potentiometer, upper:	Radiation, D9037-108 See Figure 2-35
4		BRACKET:	Radiation, B9037-823-1
5		"C" DOOR: Includes TB23 and TB24	
6		"D" DOOR: Mounted behind "C" door, includes TB25 and TB26	See Figure 2-38
7		SWITCH, toggle: with 8-59 nut	Carling Electric, Inc., AB252-BL
8	TB23	TERMINAL BOARD:	Radiation, B9037-847 See Figure 2-37
9		PIVOT:	Radiation, B9037-392
10	TB24	TERMINAL BOARD:	Radiation, B9037-848 See Figure 2-37
11		BRACKET:	Radiation, B9037-823-2
12	TB27	TERMINAL BOARD:	Radiation, B9037- See Figure 2-39
13	TB22	TERMINAL BOARD:	Radiation, B9037-845 See Figure 2-36
14		PIVOT:	Radiation, B9037-392

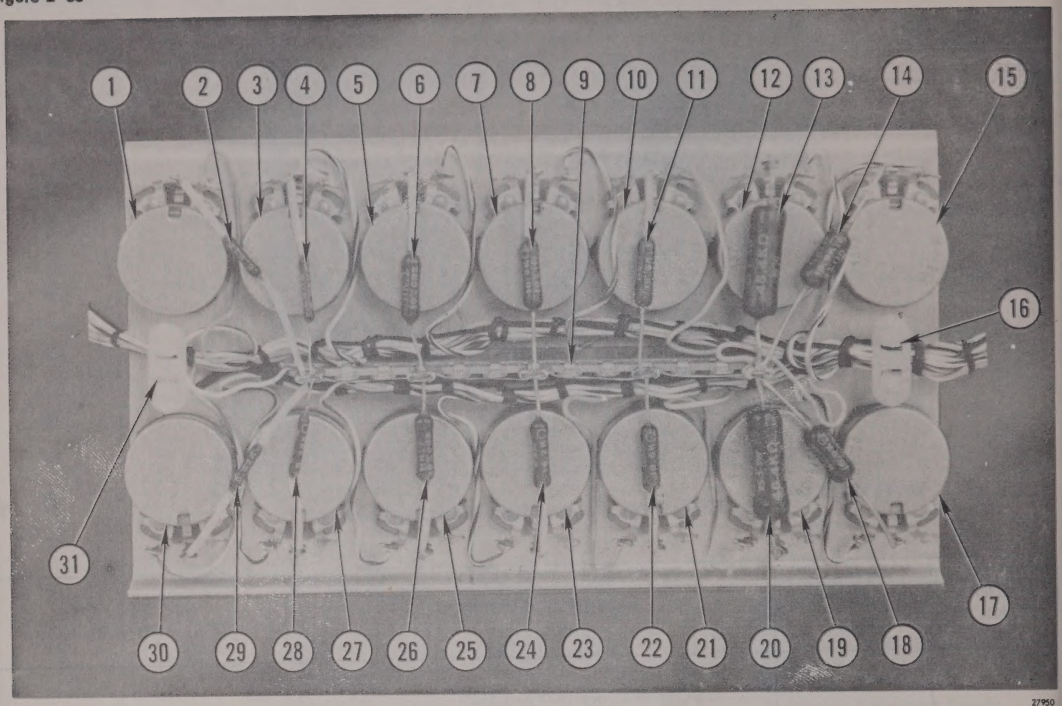

Figure 2-35. Receiver Upper Potentiometer Bracket

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1	R595	RESISTOR, variable, composition: 5k, ±10%, slotted shaft 0.5 in.lg., 3/8 in. bushing, locking type w/lock nut	Chicago Telephone Supply, FR6645
2	R581	RESISTOR, fixed, wire wound: 5.62k, ±10%, 1w	Dale Products, Inc., CS-1A
3	R596	RESISTOR, variable, composition: 5k, ±10%, slotted shaft 0.5 in. lg., 3/8 in. bushing, locking type w/lock nut	Chicago Telephone Supply, FR6645
4	R582	RESISTOR, fixed, wire wound: 8.25k, ±10%, 1w	Dale Products, Inc., CS-1B
5	R597	RESISTOR, variable, composition: 5k, ±10%, slotted shaft 0.5 in. lg., 3/8 in. bushing, locking type w/lock nut	Chicago Telephone Supply, FR6645
6	R583	RESISTOR, fixed, wire wound: 11k, ±10%, 3w	Dale Products, Inc., CS-2B
7	R598	RESISTOR, variable, composition: 10k, ±10%, slotted shaft 0.5 in. lg., 3/8 in. bushing, locking type w/lock nut	Chicago Telephone Supply, FR6648
8	R584	RESISTOR, fixed, wire wound: 16.2k, ±10%, 3w	Dale Products, Inc., CS-2B
9	TP9 (tie point)	STRIP, terminal: XXXP, phenolic	Cinch, 2013

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
10	R599	RESISTOR, variable, composition: 10k, ±10%, slotted shaft 0.5 in. lg., 3/8 in. bushing, locking type w/lock nut	Chicago Telephone Supply, FR6648
11	R585	RESISTOR, fixed, wire wound: 19.6k, ±10%, 3w	Dale Products, Inc., CS-2B
12	R600	RESISTOR, variable, composition: 10K, ±10%, slotted shaft 0.5 in. lg., 3/8 in. bushing, locking type w/lock nut	Chicago Telephone Supply, FR6648
13	R586	RESISTOR, fixed, wire wound: 46.4k, ±5%, 5w	Dale Products, Inc., CS-5
14	R587	RESISTOR, fixed, wire wound: 16.9k, ±3%, 2.5w	Dale Products, Inc., RS-2C
15	R601	RESISTOR, variable, composition: 10k, ±10%, slotted shaft 0.5 in. lg., 3/8 in. bushing, locking type w/lock nut	Chicago Telephone Supply, FR6648
16		KEEPER:	Dakota, 2C1-25A
17	R608	RESISTOR, variable, composition: 10k, ±10%, slotted shaft 0.5 in. lg., 3/8 in. bushing, locking type w/lock nut	Chicago Telephone Supply, FR6648
18	R594	RESISTOR, fixed, wire wound: 16.9k, ±3%, 2.5w	Dale Products, Inc., RS-2C
19	R607	RESISTOR, variable, composition: 10k, ±10%, slotted shaft 0.5 in. lg., 3/8 in. bushing, locking type w/lock nut	Chicago Telephone Supply, FR6648
20	R593	RESISTOR, fixed, wire wound: 46.4k, ±5%, 5w	Dale Products, Inc., CS-5
21	R606	RESISTOR, variable, composition: 10k, ±10%, slotted shaft 0.5 in. lg., 3/8 in. bushing, locking type w/lock nut	Chicago Telephone Supply, FR6648
22	R592	RESISTOR, fixed, wire wound: 19.6k, ±10%, 3w	Dale Products, Inc., CS-2B
23	R605	RESISTOR, variable, composition: 10k, ±10%, slotted shaft 0.5 in. lg., 3/8 in. bushing, locking type w/lock nut	Chicago Telephone Supply, FR6648
24	R591	RESISTOR, fixed, wire wound: 16.2k, ±10%, 3w	Dale Products, Inc., CS-2B
25	R604	RESISTOR, variable, composition: 5k, ±10%, slotted shaft 0.5 in. lg., 3/8 in. bushing, locking type w/lock nut	Chicago Telephone Supply, FR6645
26	R590	RESISTOR, fixed, wire wound: 11k, ±10%, 3w	Dale Products, Inc., CS-2B
27	R603	RESISTOR, variable, composition: 5k, ±10%, slotted shaft 0.5 in. lg., 3/8 in. bushing, locking type w/lock nut	Chicago Telephone Supply, FR6645
28	R589	RESISTOR, fixed, wire wound: 8.25k, ±10%, 1w	Dale Products, Inc., CS-1B
29	R588	RESISTOR, fixed, wire wound: 5.62k, ±10%, 1w	Dale Products, Inc., CS-1A
30	R602	RESISTOR, variable, composition: 5k, ±10%, slotted shaft 0.5 in. lg., 3/8 in. bushing, locking type w/lock nut	Chicago Telephone Supply, FR6645
31		KEEPER:	Dakota, 2C1-25A

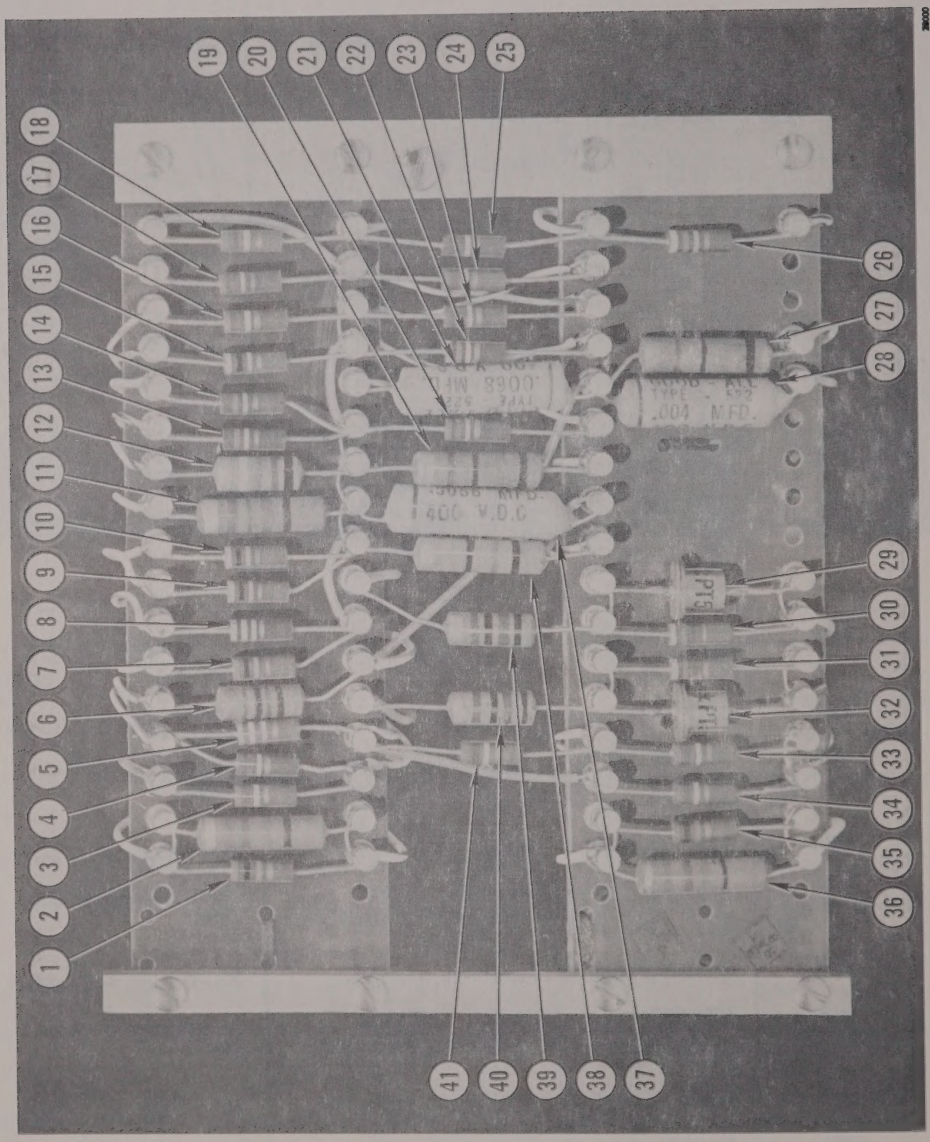

Figure 2-36. Receiver Terminal Boards, TB21 and TB22, "A" Door

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1	R554	RESISTOR, fixed, composition: 10 meg, ±5%, 1/2w	RC20GF106J
2	C435	CAPACITOR, fixed, ceramic: 1500 mmf, ±20%, 500 vdcw	Erie Resistor Corp., GP2L1500±20%
3	R568	RESISTOR, fixed, composition: 150k, ±5%, 1/2w	RC20GF154J
4	R567	RESISTOR, fixed, composition: 220k, ±5%, 1/2w	RC20GF224J
5	R566	RESISTOR, fixed, composition: 390k, ±5%, 1/2w	RC20GF394J
6	C457	CAPACITOR, fixed, ceramic: 2000 mmf, ±20%, 500 vdc	Erie Resistor Corp., GP3K2000±20%
7	R410	RESISTOR, fixed, composition: 10k, ±5%, 1/2w	RC20GF103J
8	R575	RESISTOR, fixed, composition: 33k, ±5%, 1/2w	RC20GF333J
9	R479	RESISTOR, fixed, composition: 56k, ±5%, 1/2w	RC20GF563J
10	R478	RESISTOR, fixed, composition: 56k, ±5%, 1/2w	RC20GF563J
11	C453	CAPACITOR, fixed, ceramic: 1500 mmf, ±20%, 500 vdcw	Erie Resistor Corp., GP2L1500±20%
12	C455	CAPACITOR, fixed, ceramic: 470 mmf, ±20%, 500 vdcw	Erie Resistor Corp., GP2K470±20%
13	R463	RESISTOR, fixed, composition: 30k, ±5%, 1/2w	RC20GF303J
14	R464	RESISTOR, fixed, composition: 30k, ±5%, 1/2w	RC20GF303J
15	R610	RESISTOR, fixed, composition: 300k, ±5%, 1/2w	RC20GF304J
16	R613	RESISTOR, fixed, composition: 120k, ±5%, 1/2w	RC20GF124J
17	R553	RESISTOR, fixed, composition: 12k, ±5%, 1/2w	RC20GF123J
18	R552	RESISTOR, fixed, composition: 150k, ±5%, 1/2w	RC20GF154J
19	C454	CAPACITOR, fixed, ceramic: 1000 mmf, ±20%, 500 vdcw	Erie Resistor Corp., GP2L1000±20%
20	R437	RESISTOR, fixed, composition: 82k, ±5%, 1/2w	RC20GF823J
21	C459	CAPACITOR, fixed, paper: 0.0068 mfd, ±20%, 400 vdcw	Good-All, 522M68204W2
22	R609	RESISTOR, fixed, composition: 470k, ±5%, 1/2w	RC20GF474J
23	R611	RESISTOR, fixed, composition: 220k, ±5%, 1/2w	RC20GF224J
24	R612	RESISTOR fixed, composition: 150k, ±5%, 1/2w	RC20GF154J
25	R577	RESISTOR, fixed, composition: 220k, ±5%, 1/2w	RC20GF224J
26	R407	RESISTOR, fixed, composition: 47k, ±5%, 1/2w	RC20GF473J
27	C456	CAPACITOR, fixed, ceramic: 1000 mmf, ±20%, 500 vdcw	Erie Resistor Corp., GP2L1000±20%

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
28	C458	CAPACITOR, fixed, paper: 0.004 mfd, ±20%, 400 vdcw	Good-All, 522M40204W2
29	CR418	DIODE:	Radio Receptor, PT5
30	R557	RESISTOR, fixed, composition: 4.7 meg, ±5%, 1/2w	RC20GF475J
31	R556	RESISTOR, fixed, composition: 4.7 meg, ±5%, 1/2w	RC20GF475J
32	CR417	DIODE:	Radio Receptor, PT5
33	R564	RESISTOR, fixed, composition: 150k, ±5%, 1/2w	RC20GF154J
34	R579	RESISTOR, fixed, composition: 150k, ±5%, 1/2w	RC20GF154J
35	R555	RESISTOR, fixed, composition: 10 meg, ±5%, 1/2w	RC20GF106J
36	C436	CAPACITOR, fixed, ceramic: 1500 mmf, ±20%, 500 vdcw	Erie Resistor Corp., GP2L1500±20%
37	C451	CAPACITOR, fixed, paper: 0.0056 mfd, ±20%, 400 vdcw	Good-All, 522M56204W2
38	C452	CAPACITOR, fixed, ceramic: 3000 mmf, ±20%, 500 vdcw	Erie Resistor Corp., GP3L3000±20%
39	C439	CAPACITOR, fixed, ceramic: 100 mmf, ±20%, 500 vdcw	Erie Resistor Corp., GP1K100±20%
40	C438	CAPACITOR, fixed, ceramic: 100 mmf, ±20%, 500 vdcw	Erie Resistor Corp., GP1K100±20%
41	R565	RESISTOR, fixed, composition: 150k, ±5%, 1/2w	RC20GF154J

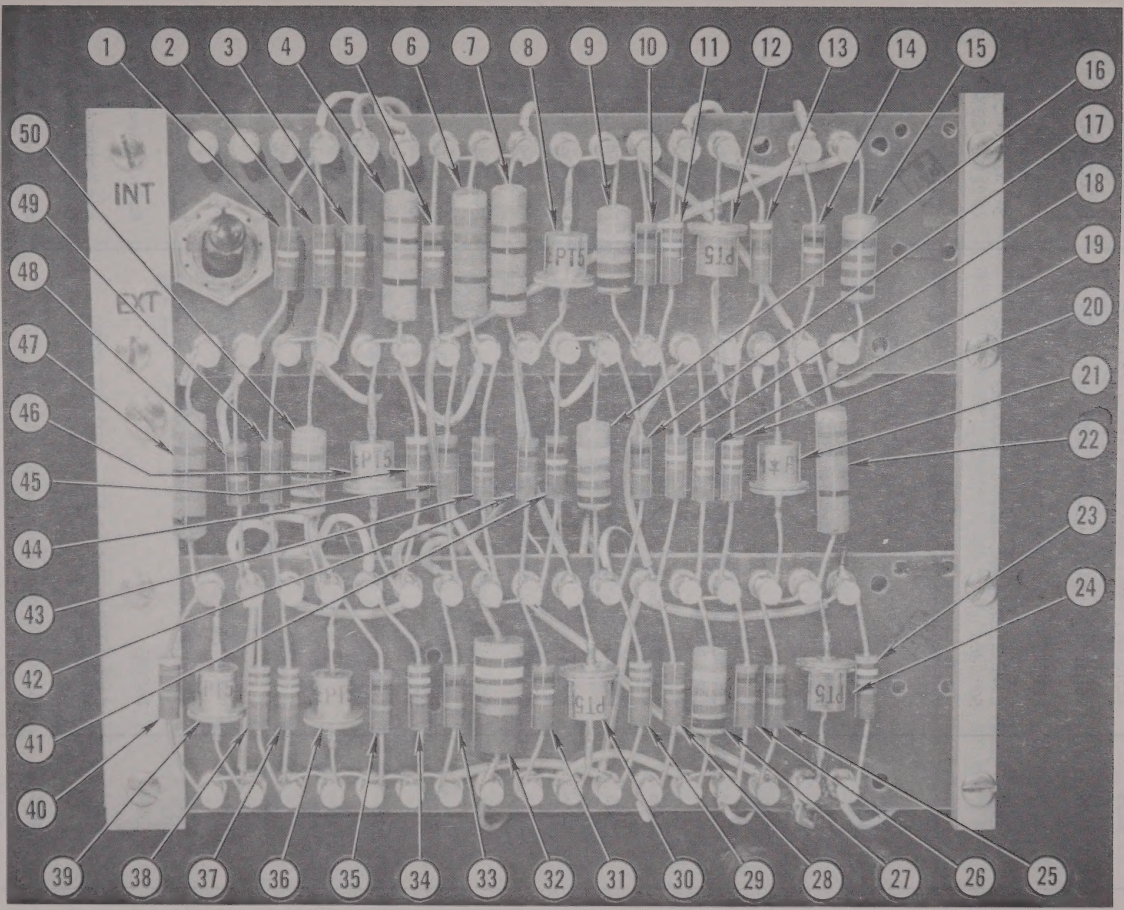

Figure 2-37. Receiver Terminal Boards, TB23 and TB24, "D" Door

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1	R425	RESISTOR, fixed, composition: 220k, ±5%, 1/2w	RC20GF224J
2	R429	RESISTOR, fixed, composition: 220k, ±5%, 1/2w	RC20GF224J
3	R432	RESISTOR, fixed, composition: 820k, ±5%, 1/2w	RC20GF824J
4	C405	CAPACITOR, fixed, ceramic: 1000 mmf, ±20%, 500 vdcw	Erie Resistor Corp., GP2L1000±20%
5	R500	RESISTOR, fixed, composition: 100k, ±5%, 1/2w	RC20GF104J
6	C415	CAPACITOR, fixed, ceramic: 1500 mmf, ±20%, 500 vdcw	Erie Resistor Corp., GP2L1500±20%
7	C417	CAPACITOR, fixed, ceramic: 1000 mmf, ±20%, 500 vdcw	Erie Resistor Corp., GP2L1000±20%
8	CR407	DIODE:	Radio Receptor, PT5
9	C419	CAPACITOR, fixed, ceramic: 470 mmf, ±20%, 500 vdcw	Erie Resistor Corp., GP2K470±20%
10	R506	RESISTOR, fixed, composition: 1.0 meg, ±5%, 1/2w	RC20GF105J
11	R505	RESISTOR, fixed, composition: 470k, ±5%, 1/2w	RC20GF474J
12	CR408	DIODE:	Radio Receptor, PT5
13	R513	RESISTOR, fixed, composition: 4.7 meg, ±5%, 1/2w	RC20GF475J
14	R507	RESISTOR, fixed, composition: 100k, ±5%, 1/2w	RC20GF104J
15	C420	CAPACITOR, fixed, ceramic: 150 mmf, ±20%, 500 vdcw	Erie Resistor Corp., GP2K150±20%
16	C414	CAPACITOR, fixed, ceramic: 470 mmf, ±20%, 500 vdcw	Erie Resistor Corp., GP2K470±20%
17	R497	RESISTOR, fixed, composition: 1.0 meg, ±5%, 1/2w	RC20GF105J
18	R504	RESISTOR, fixed, composition: 270k, ±5%, 1/2w	RC20GF274J
19	R512	RESISTOR, fixed, composition: 270k, ±5%, 1/2w	RC20GF274J
20	R511	RESISTOR, fixed, composition: 470k, ±5%, 1/2w	RC20GF474J
21	CR410	DIODE:	Radio Receptor, PT5
22	C421	CAPACITOR, fixed, ceramic: 1500 mmf, ±20%, 500 vdcw	Erie Resistor Corp., GP2L1500±20%
23	R421	RESISTOR, fixed, composition: 39k, ±5%, 1/2w	RC20GF393J
24	CR409	DIODE:	Radio Receptor, PT5
25	R519	RESISTOR, fixed, composition: 1.0 meg, ±5%, 1/2w	RC20GF105J
26	R510	RESISTOR, fixed, composition: 1.0 meg, ±5%, 1/2w	RC20GF105J
27	C418	CAPACITOR, fixed, ceramic: 470 mmf, ±20%, 500 vdcw	Erie Resistor Corp., GP2K470±20%

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
28	R503	RESISTOR, fixed, composition: 22k, ±5%, 1/2w	RC20GF223J
29	R498	RESISTOR, fixed, composition: 330k, ±5%, 1/2w	RC20GF334J
30	CR406	DIODE:	Radio Receptor, PT5
31	R509	RESISTOR, fixed, composition: 100k, ±5%, 1/2w	RC20GF104J
32	R501	RESISTOR, fixed, composition: 39k, ±5%, 2w	RC42GF393J
33	R495	RESISTOR, fixed, composition: 1.0 meg, ±5%, 1/2w	RC20GF105J
34	R492	RESISTOR, fixed, composition: 39k, ±5%, 1/2w	RC20GF393J
35	R576	RESISTOR, fixed, composition: 1.0 meg, ±5%, 1/2w	RC20GF105J
36	CR419	DIODE:	Radio Receptor, PT5
37	R426	RESISTOR, fixed, composition: 330k, ±5%, 1/2w	RC20GF334J
38	R422	RESISTOR fixed, composition: 330k, ±5%, 1/2w	RC20GF334J
39	CR401	DIODE:	Radio Receptor, PT5
40	R430	RESISTOR, fixed, composition: 4.7 meg, ±5%, 1/2w	RC20GF475J
41	R496	RESISTOR, fixed, composition: 100k, ±5%, 1/2w	RC20GF104J
42	R508	RESISTOR, fixed, composition: 1.0 meg, ±5%, 1/2w	RC20GF105J
43	R502	RESISTOR, fixed, composition: 820k, ±5%, 1/2w	RC20GF824J
44	R493	RESISTOR, fixed, composition: 1.0 meg, ±5%, 1/2w	RC20GF105J
45	R431	RESISTOR, fixed, composition: 4.7 meg, ±5%, 1/2w	RC20GF475J
46	CR402	DIODE:	Radio Receptor, PT5
47	C404	CAPACITOR, fixed, ceramic: 1000 mmf, ±20%, 500 vdcw	Erie Resistor Corp., GP2L1000±20%
48	R424	RESISTOR, fixed, composition: 1.0 meg, ±5%, 1/2w	RC20GF105J
49	R428	RESISTOR, fixed, composition: 1.2 meg, ±5%, 1/2w	RC20GF125J
50	C443	CAPACITOR, fixed, ceramic: 100 mmf, ±20%, 500 vdcw	Erie Resistor Corp. GP1K100±20%

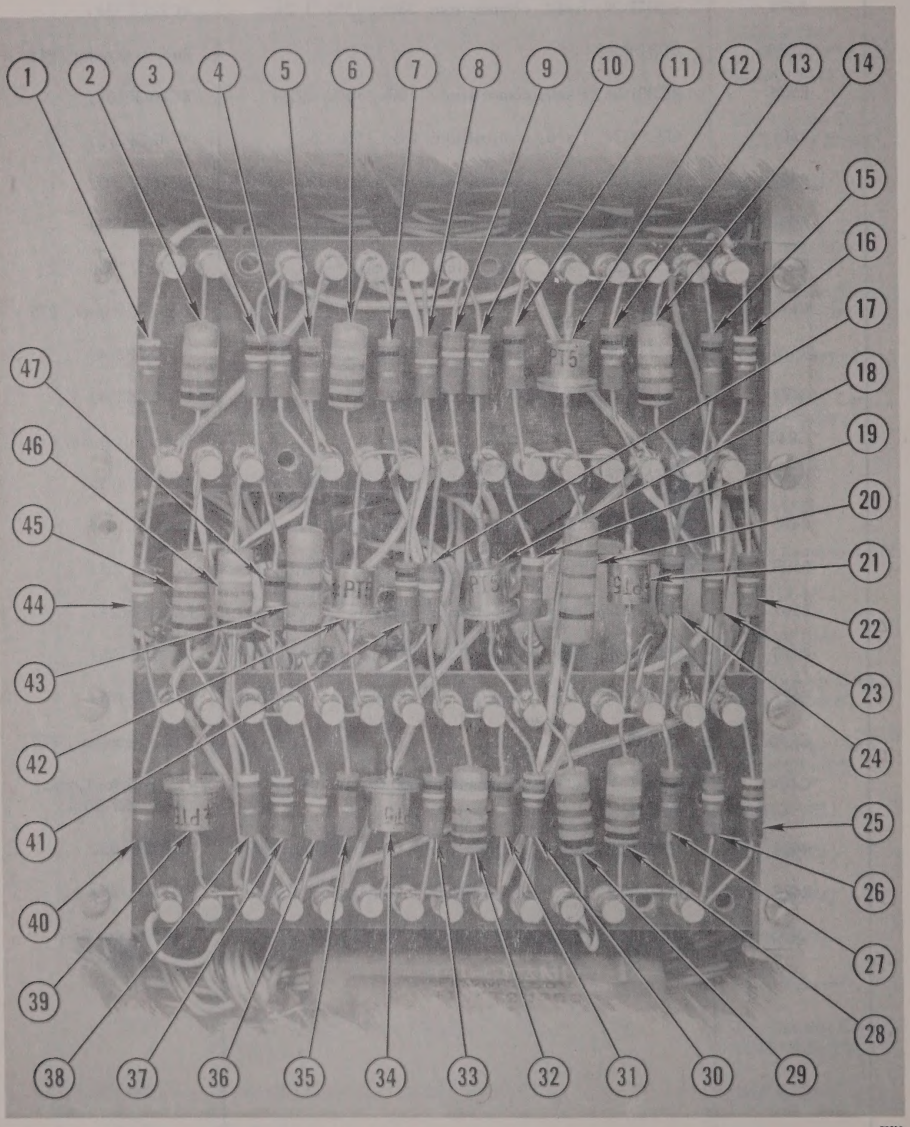

Figure 2-38. Receiver Terminal Boards, TB25 and TB26, "B" Door

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1	R516	RESISTOR, fixed, composition: 470k, ±5%, 1/2w	RC20GF474J
2	C423	CAPACITOR, fixed, ceramic: 470 mfd, ±20%, 500 vdcw	Erie Resistor Corp., GP2K470±20%
3	R520	RESISTOR, fixed, composition: 100k, ±5%, 1/2w	RC20GF104J
4	R518	RESISTOR, fixed, composition: 100k, ±5%, 1/2w	RC20GF104J
5	R517	RESISTOR, fixed, composition: 1.0 meg, ±5%, 1/2w	RC20GF105J
6	C426	CAPACITOR, fixed, ceramic: 470 mfd, ±20%, 500 vdcw	Erie Resistor Corp., GP2K470±20%
7	R532	RESISTOR, fixed, composition: 1.0 meg, ±5%, 1/2w	RC20GF105J
8	R525	RESISTOR, fixed, composition: 22k, ±5%, 1/2w	RC20GF223J
9	R534	RESISTOR, fixed, composition: 270k, ±5%, 1/2w	RC20GF274J
10	R533	RESISTOR, fixed, composition: 470k, ±5%, 1/2w	RC20GF474J
11	R541	RESISTOR, fixed, composition: 1.0 meg, ±5%, 1/2w	RC20GF105J
12	CR416	DIODE:	Radio Receptor, PT5
13	R540	RESISTOR, fixed, composition: 100k, ±5%,1/2w	RC20GF104J
14	C431	CAPACITOR, fixed, ceramic: 470 mmf, ±20%, 500 vdcw	Erie Resistor Corp., GP2K470±20%
15	R539	RESISTOR, fixed, composition: 1.0 meg, ±5%, 1/2w	RC20GF105J
16	R538	RESISTOR, fixed, composition: 470k, ±5%, 1/2w	RC20GF474J
17	R526	RESISTOR, fixed, composition: 270k, ±5%, 1/2w	RC20GF274J
18	CR414	DIODE:	Radio Receptor, PT5
19	R535	RESISTOR, fixed, composition: 4.7 meg, ±5%, 1 2w	RC20GF475J
20	C429	CAPACITOR, fixed, ceramic: 1500 mmf, ±20%, 500 vdcw	Erie Resistor Corp., GP2L1500±20%
21	CR415	DIODE:	Radio Receptor, PT5
22	R536	RESISTOR, fixed, composition: 22k, ±5%, 1/2w	RC20GF223J
23	R537	RESISTOR, fixed, composition: 270k, ±5%, 1/2w	RC20GF274J
24	R542	RESISTOR, fixed, composition: 100k, ±5%, 1/2w	RC20GF104J
25	R544	RESISTOR, fixed, composition: 470k, ±5%, 1/2w	RC20GF474J
26	R545	RESISTOR, fixed, composition: 270k, ±5%, 1/2w	RC20GF274J
27	R543	RESISTOR, fixed, composition: 1.0 meg, ±5%, 1/2w	RC20GF105J
28	C430	CAPACITOR, fixed, composition: 470 mmf, ±20%, 500 vdcw	Erie Resistor Corp., GP2K470±20%

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
29	C428	CAPACITOR, fixed, composition: 150 mmf, ±20%, 500 vdcw	Erie Resistor Corp., GP2K150±20%
30	R527	RESISTOR, fixed, composition: 470k, ±5%, 1/2w	RC20GF474J
31	R528	RESISTOR, fixed, composition: 1.0 meg, ±5%, 1/2w	RC20GF105J
32	C427	CAPACITOR, fixed, ceramic: 470 mmf, ±20%, 500 vdcw	Erie Resistor Corp., GP2K470±20%
33	R529	RESISTOR, fixed, composition: 100k, ±5%, 1/2w	RC20GF104J
34	CR413	DIODE:	Radio Receptor, PT5
35	R530	RESISTOR, fixed, composition: 1.0 meg, ±5%, 1/2w	RC20GF105J
36	R523	RESISTOR, fixed, composition: 270k, ±5%, 1/2w	RC20GF274J
37	R522	RESISTOR, fixed, composition: 470k, ±5%, 1/2w	RC20GF474J
38	R524	RESISTOR, fixed, composition: 4.7 meg, ±5%, 1/2w	RC20GF475J
39	CR411	DIODE:	Radio Receptor, PT5
40	R514	RESISTOR, fixed, composition: 22k, ±5%, 1/2w	RC20GF223J
41	R531	RESISTOR, fixed, composition: 100k, ±5%, 1/2w	RC20GF104J
42	CR412	DIODE:	Radio Receptor, PT5
43	C425	CAPACITOR, fixed, ceramic: 1500 mmf, ±20%, 500 vdcw	Erie Resistor Corp., GP2L1500±20%
44	R515	RESISTOR, fixed, composition: 270k, ±5%, 1/2w	RC20GF274J
45	C424	CAPACITOR, fixed, ceramic: 150 mmf, ±20%, 500 vdcw	Erie Resistor Corp., GP2K150±20%
46	C422	CAPACITOR, fixed, ceramic: 470 mmf, ±20%, 500 vdcw	Erie Resistor Corp., GP2K470±20%
47	R521	RESISTOR, fixed, composition: 1.0 meg, ±5%, 1/2w	RC20GF105J

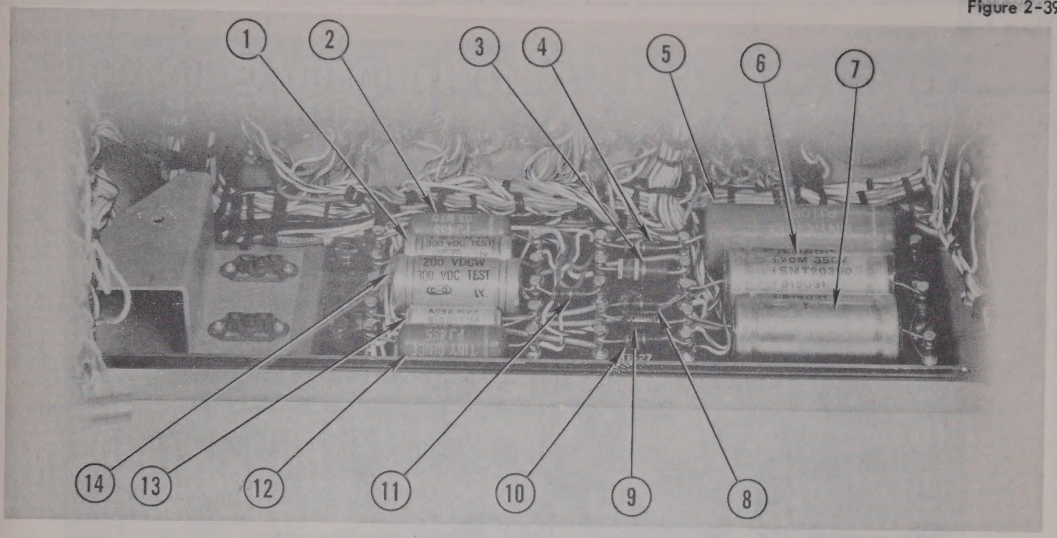

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Figure 2-39. Receiver Terminal Boards, TB27

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1	C433	CAPACITOR, fixed, paper: 0.5 mfd, ±20%, 200 vdcw	Cornell-Dubilier, MTM-2-P5
2	C408	CAPACITOR, fixed, paper: 0.05 mfd, ±20%, 400 vdcw	Cornell-Dubilier, PJ4S5
3	R551	RESISTOR, fixed, composition: 470k, ±5%, 1w	RC32GF474J
4	R571	RESISTOR, fixed, composition: 100k, ±5%, 1/2w	RC20GF104J
5	C442	CAPACITOR, fixed, paper: 0.1 mfd, ±20%, 1000 vdcw	Cornell-Dubilier, PJ-10-P1
6	C445	CAPACITOR, fixed, electrolytic: 20 mfd, -10% +50%, 350 vdcw	Illinois Condenser Corp., SMT20350
7	C444	CAPACITOR, fixed, electrolytic: 20 mfd, -10% +50%, 350 vdcw	Illinois Condenser Corp., SMT20350
8	R573	RESISTOR, fixed, composition: 1.0k, ±5%, 1/2w	RC20GF102J
9	R572	RESISTOR, fixed, wire wound: 2.7k, ±5%, 3w	Ohmite, per Radiation A9037-1372
10	R416	RESISTOR, fixed, composition: 8.2k, ±5%, 1/2w	RC20GF822J
11	R569	RESISTOR, fixed, composition: 1.0 meg, ±5%, 1/2w	RC20GF105J
12	C437	CAPACITOR, fixed, paper: 0.05 mfd, ±20%, 400 vdcw	Cornell-Dubilier, PJ4S5
13	C434	CAPACITOR, fixed, electrolytic: 4 mfd, -10% +50%, 250 vdcw	Illinois Condenser Corp., SMT4250
14	C440	CAPACITOR, fixed, paper: 1.0 mfd, ±20%, 200 vdcw	Cornell-Dubilier, MTM-2-P5

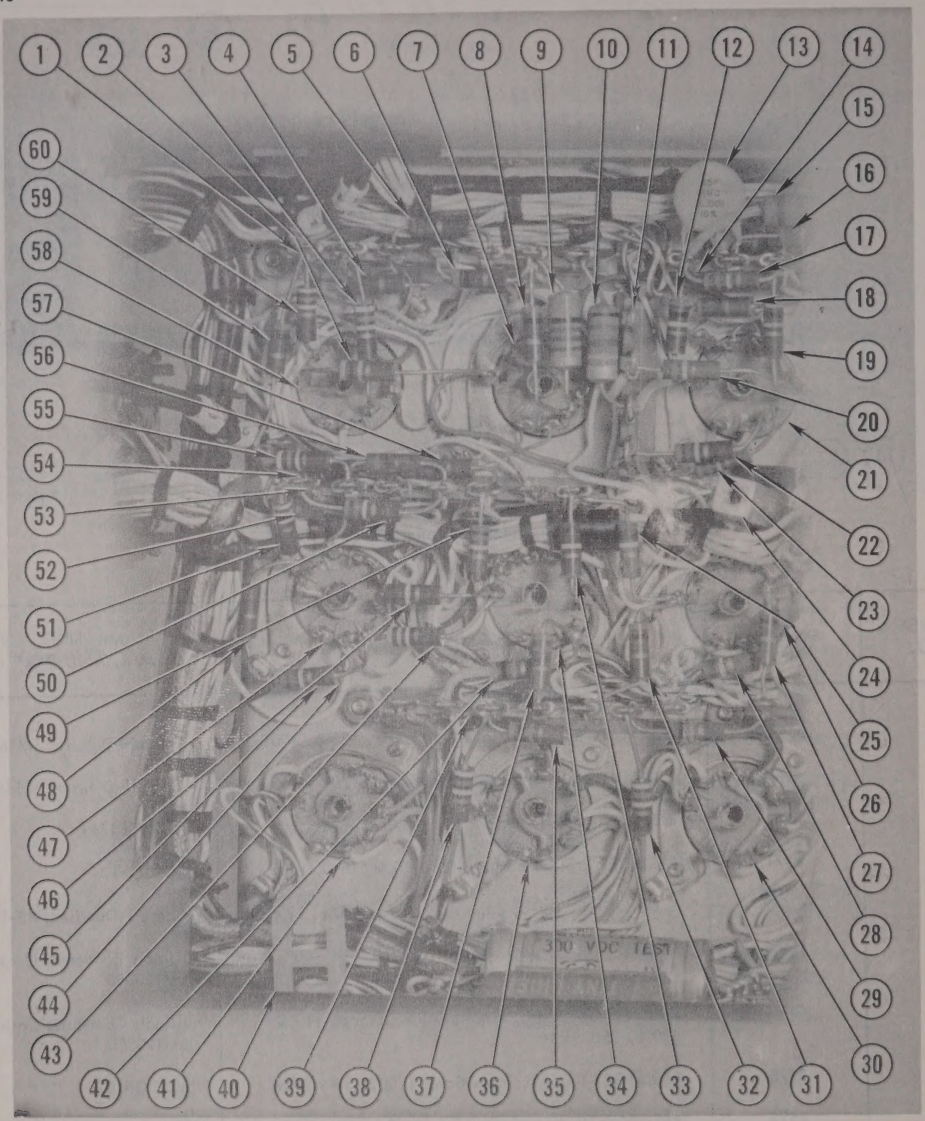

Figure 2-40. Receiver Chassis, Rear View, Left Side

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1	TP1 (tie point)	STRIP, terminal: XXXP, phenolic	Cinch, 2007
2	R412	RESISTOR, fixed, composition: 30k, ±5%, 1/2w	RC20GF303J
3	R563	RESISTOR, fixed, composition: 470k, ±5%, 1/2w	RC20GF474J

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
4	R561	RESISTOR, fixed, composition: 1.0 meg, ±5%, 1/2w	RC20GF105J
5	R466	RESISTOR, fixed, composition: 2.2k, ±5%, 1/2w	RC20GF222J
6	R404	RESISTOR, fixed, composition: 1.0 meg, ±5%, 1/2w	RC20GF105J
7	XV1	TUBE SOCKET: 9-pin, miniature	Cinch, TS103P01
8	R408	RESISTOR, fixed, composition: 1.0 meg, ±5%, 1/2w	RC20GF105J
9	C447	CAPACITOR, fixed, ceramic: 150 mmf, ±20%, 500 vdcw	Erie Resistor Corp., GP2K150±20%
10	C403	CAPACITOR, fixed, ceramic: 470 mmf, ±20%, 500 vdcw	Erie Resistor Corp., GP2K470±20%
11	TP4 (tie point)	STRIP, terminal: XXXP, phenolic	Cinch, 2004
12	R418	RESISTOR, fixed, composition: 100k, ±5%, 1/2w	RC20GF104J
13	C432	CAPACITOR, fixed, ceramic: 0.001 mfd, ±10%	Radio Materials Corp., JL.001-1/2
14	R419	RESISTOR, fixed, composition: 18k, ±5%, 1/2w	RC20GF183J
15	C416	CAPACITOR, fixed, ceramic: 1000 mmf, ±20%, 500 vdcw	Erie Resistor Corp., GP2L1000±20%
16	R548	RESISTOR, fixed, composition: 100k, ±5%, 1/2w	RC20GF104J
17	R547	RESISTOR, fixed, composition: 1.0 meg, ±5%, 1/2w	RC20GF105J
18	R420	RESISTOR, fixed, composition: 1.2 meg, ±5%, 1/2w	RC20GF125J
19	R417	RESISTOR, fixed, composition: 30k, ±5%, 1/2w	RC20GF303J
20	R413	RESISTOR, fixed, composition: 270k, ±5%, 1/2w	RC20GF274J
21	XV2	TUBE SOCKET: 9-pin, miniature	Cinch, TS103P01
22	R414	RESISTOR, fixed, composition: 120k, ±5%, 1/2w	RC20GF124J
23	R415	RESISTOR, fixed, composition: 68k, ±5%, 1/2w	RC20GF683J
24		SPACER:	Radiation, A9037-321
25	R489	RESISTOR, fixed, composition: 150k, ±5%, 1/2w	RC20GF154J
26	XV7	TUBE SOCKET: 9-pin, miniature	Cinch, TS103P01
27	R482	RESISTOR, fixed, composition: 1.0 meg, ±5%, 1/2w	RC20GF105J
28	R481	RESISTOR, fixed, composition: 150k, ±5%, 1/2w	RC20GF154J
29	R483	RESISTOR, fixed, composition: 10 meg, ±5%, 1/2w	RC20GF106J
30	XV11	TUBE SOCKET: 9-pin, miniature	Cinch, TS103P01
31	R488	RESISTOR, fixed, composition: 1.0 meg, ±5%, 1/2w	RC20GF105J

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
32	R484	RESISTOR, fixed, composition: 470k, ±5%, 1/2w	RC20GF474J
33	R469	RESISTOR, fixed, composition: 220k, ±5%, 1/2w	RC20GF224J
34	XV6	TUBE SOCKET: 9-pin, miniature	Cinch, TS103P01
35	R487	RESISTOR, fixed, composition: 10 meg, ±5%, 1/2w	RC20GF106J
36	XV12	TUBE SOCKET: 9-pin, miniature	Cinch, TS103P01
37	R462	RESISTOR, fixed, composition: 6.8 meg, ±5%, 1/2w	RC20GF685J
38	R486	RESISTOR, fixed, composition: 470k, ±5%, 1/2w	RC20GF474J
39	TP7 (tie point)	STRIP, terminal: XXXP, phenolic	Cinch, 2007
40		KEEPER, cable clamp:	Dakota, 2C1-37A
41	XV13	TUBE SOCKET: 9-pin, miniature	Cinch, TS103P01
42	R468	RESISTOR, fixed, composition: 10 meg, ±5%, 1/2w	RC20GF106J
43	R444	RESISTOR, fixed, composition: 330k, ±5%, 1/2w	RC20GF334J
44	R443	RESISTOR, fixed, composition: 2.2 meg, ±5%, 1/2w (located beneath R441)	RC20GF225J
45	R441	RESISTOR, fixed, composition: 110k, ±5%, 1/2w	RC20GF114J
46	R477	RESISTOR, fixed, composition: 220k, ±5%, 1/2w	RC20GF224J
47	XV5	TUBE SOCKET: 9-pin, miniature	Cinch, TS103P01
48	R445	RESISTOR, fixed, composition: 2.2 meg, ±5%, 1/2w	RC20GF225J
49	R476	RESISTOR, fixed, composition: 680k, ±5%, 1/2w	RC20GF684J
50	R470	RESISTOR, fixed, composition: 680k, ±5%, 1/2w	RC20GF684J
51	R446	RESISTOR, fixed, composition: 330k, ±5%, 1/2w	RC20GF334J
52	R442	RESISTOR, fixed, composition: 110k, ±5%, 1/2w	RC20GF114J
53	TP5 (tie point)	STRIP, terminal: XXXP, phenolic	Cinch, 2007
54	R474	RESISTOR, fixed, composition: 470k, ±5%, 1/2w (located beneath R472)	RC20GF474J
55	R472	RESISTOR, fixed, composition: 470k, ±5%, 1/2w	RC20GF474J
56	R471	RESISTOR, fixed, composition: 2.7 meg, ±5%, 1/2w	RC20GF275J
57	R475	RESISTOR, fixed, composition: 2.7 meg, ±5%, 1/2w	RC20GF275J
58	XV14	TUBE SOCKET: 9-pin, miniature	Cinch, TS103P01
59	R560	RESISTOR, fixed, composition: 1.0 meg, ±5%, 1/2w	RC20GF105J
60	R559	RESISTOR, fixed, composition: 470k, ±5%, 1/2w	RC20GF474J

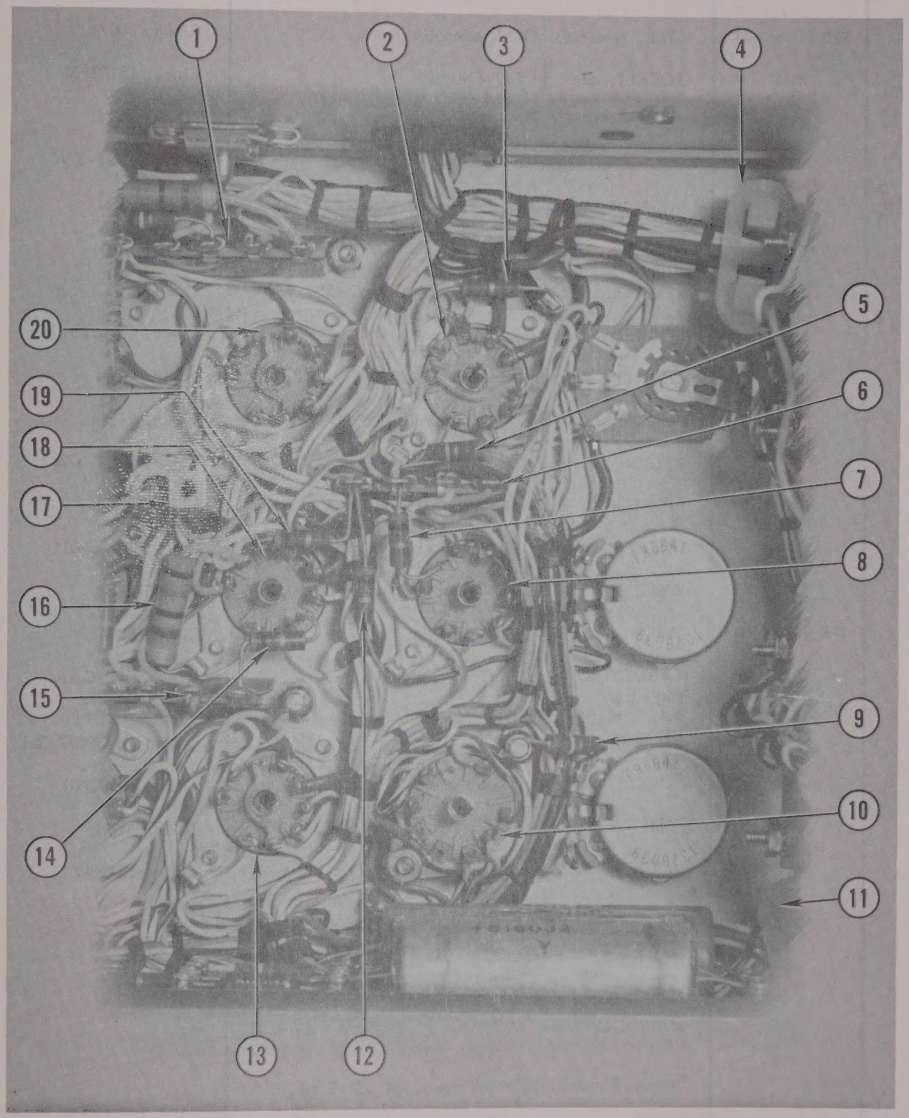

Figure 2-41. Receiver Chassis, Rear View, Right Side

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1	TP3 (tie point)	STRIP, terminal: XXXP, phenolic	Cinch, 2007
2	XV4	SOCKET, tube: 9-pin, miniature	Cinch, TS103P01
3	R438	RESISTOR, fixed, composition: 8.2k, ±5%, 1/2w	RC20GF822J
4		KEEPER, cable clamp:	Dakota, 2C1-37A
5	R435	RESISTOR, fixed, composition: 22k, ±5%, 1/2w	RC20GF223J
6	TP6 (tie point)	STRIP, terminal: XXXP, phenolic	Cinch, 2004
7	R499	RESISTOR, fixed, composition: 1.0 meg, ±5%, 1/2w	RC20GF105J
8	XV9	SOCKET, tube: 9-pin, miniature	Cinch, TS103P01
9	R433	RESISTOR, fixed, composition: 820k, ±5%, 1/2w	RC20GF824J
10	XRL1	SOCKET, tube: 9-pin, miniature	Cinch, 9-EM
11		KEEPER:	Dakota, 2C1-37A
12	R491	RESISTOR, fixed, composition: 1.0 meg, ±5%, 1/2w	RC20GF105J
13	XV10	SOCKET, tube: 9-pin, miniature	Cinch, TS103P01
14	R494	RESISTOR, fixed, composition: 1.0 meg, ±5%, 1/2w	RC20GF105J
15	TP8 (tie point)	STRIP, terminal: XXXP, phenolic	Cinch, 2004
16	C450	CAPACITOR, fixed, ceramic: 450 mmf, ±20%, 500 vdcw	Erie Resistor Corp., GP2L450±20%
17		SPACER:	Radiation, C9037-321
18	XV8	SOCKET, tube: 9-pin, miniature	Cinch, TS103P01
19	R490	RESISTOR, fixed, composition: 1.0 meg, ±5%, 1/2w	RC20GF105J
20	XV3	SOCKET, tube: 9-pin, miniature	Cinch, TS103P01

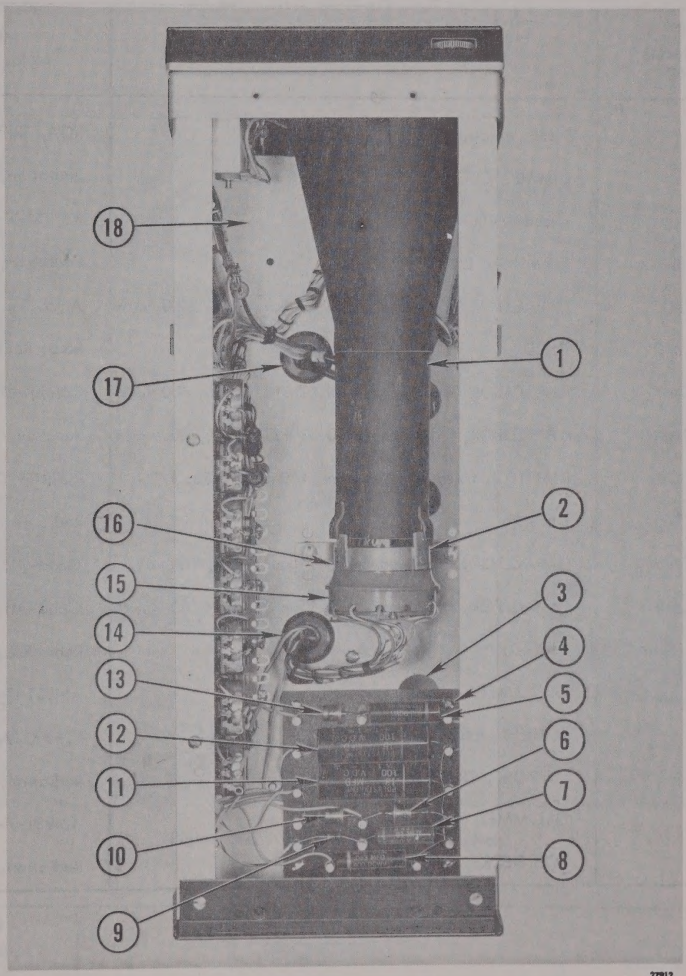

Figure 2-42. Receiver, Top View, Cover Removed

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1		TUBE, electron: cathode ray	RCA, 3RP1
2		CLAMP: CRT	Radiation, B9037-705
3		GROMMET: rubber	AN931-7-11
4	TB28	TERMINAL BOARD:	Radiation, B9037-131
5	C407	CAPACITOR, fixed, paper: 0.03 mfd, ±20%, 400 vdcw	Aerovox, V-161-83
6	CR405	DIODE:	Radio Receptor, PT5
7	C441	CAPACITOR, fixed, paper: 0.01 mfd, ±20%, 400 vdcw	Cornell-Dubilier, PJ4S1
8	C406	CAPACITOR, fixed, paper: 0.03 mfd, ±20%, 400 vdcw	Aerovox, V-161-83
9	R580	RESISTOR, fixed, composition: 1.0 meg, ±5%, 1/2w	RC20GF105J
10	CR404	DIODE:	Radio Receptor, PT5
11	C409	CAPACITOR, fixed, paper: 0.13 mfd, ±1%, 100 vdcw	Good-All, 820UB13411W2
12	C410	CAPACITOR, fixed, paper: 0.15 mfd, ±1%, 100 vdcw	Good-All, 820UB15411W2
13	CR403	DIODE:	Radio Receptor, PT5
14		GROMMET: rubber	AN931-7-11
15		SOCKET, tube: CRT, duodecal	Cinch, 3M-12
16		SUPPORT, CRT base:	Radiation, A9037-709
17		GROMMET: rubber	AN931-7-11
18		TOP DECK:	Radiation, D9037-123

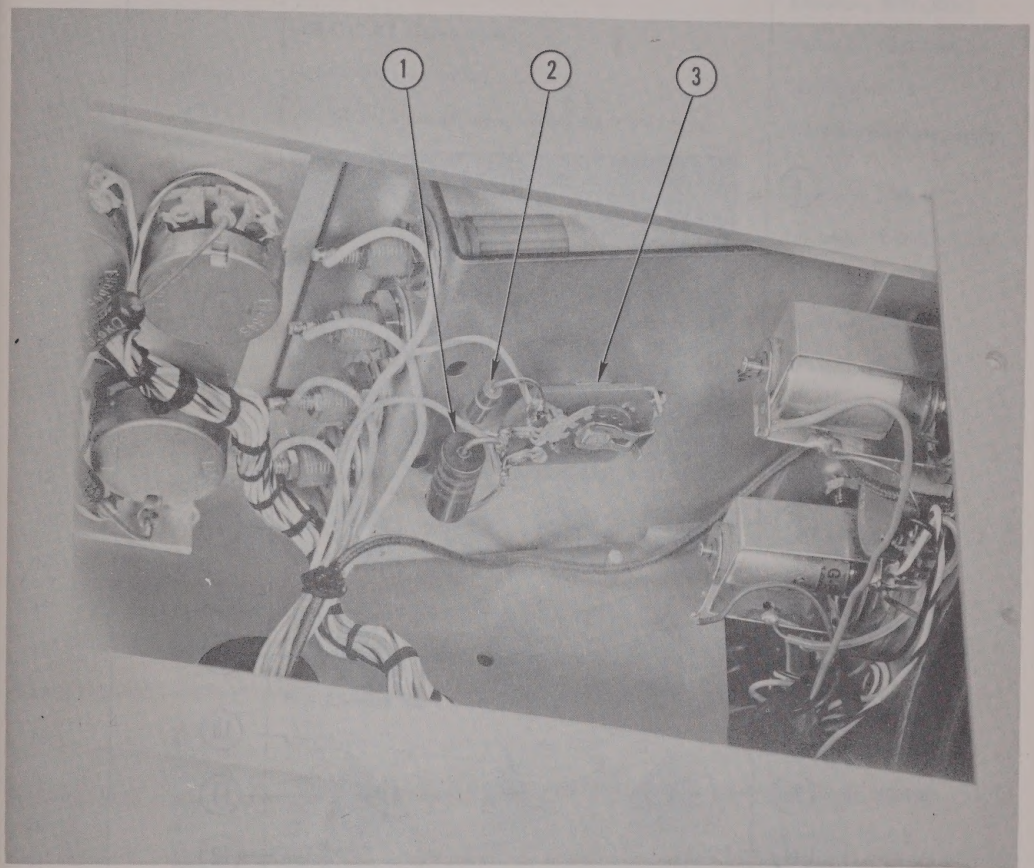

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Figure 2-43. Receiver Impedance Switch

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1	R402	RESISTOR, fixed, composition: 270 ohms, ±5%, 2w	RC42GF271J
2	R401	RESISTOR, fixed, composition: 220k, ±5%, 1/2w	RC20GF224J
3	S409	SWITCH, rotary:	Radiation, C9037-305

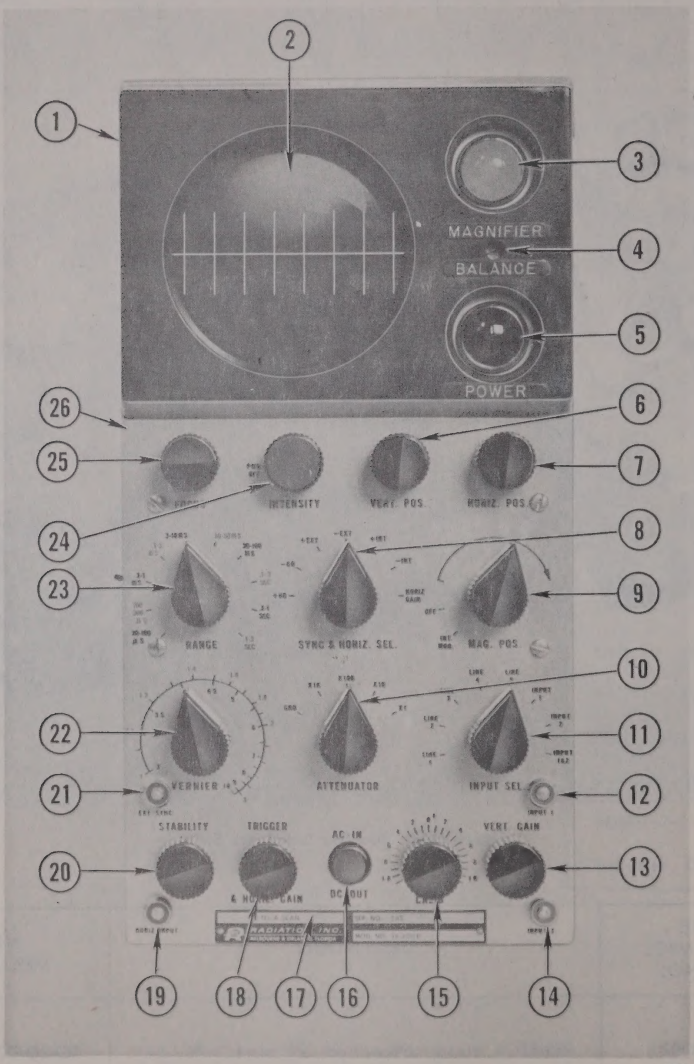


Figure 2-44. Tel-A-Scan Front Panel

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1		BEZEL, molded:	Radiation, 9037-380-2
2		GRATICULE, Tel-A-Scan:	Radiation, 9037-739
3	I2	INDICATOR, magnifier:	See Figure 2-48
4	R719	RESISTOR, variable, composition: 1k, 10%, 1/2w	Chicago Telephone Supply, KF-5725
5	I1	INDICATOR, power:	See Figure 2-48
6	A	KNOB, round, skirted: black (for R726)	Raytheon, 70-2-2
7	A	KNOB, round, skirted: black (for R779)	Raytheon, 70-2-2
8	C	KNOB, pointer, skirted: (for S753)	Raytheon, 70-5-2
9	C	KNOB, pointer, skirted: (for S754)	Raytheon, 70-5-2
10	C	KNOB, pointer, skirted: (for S752)	Raytheon, 70-5-2
11	C	KNOB, pointer, skirted: (for S750)	Raytheon, 70-5-2
12	J701	CONNECTOR, single contact, male, w/ nut:	Switchcraft, 5501MP
13	A	KNOB, round, skirted: black (for R716)	Raytheon, 70-2-2
14	J702	CONNECTOR, single contact, male, w/nut:	Switchcraft, 5501MP
15	E	KNOB, round, skirted: black (for R815)	Radiation, 9037-735
16	D	KNOB, pushbutton: 0.052 x 0.187 flat shaft (for S751)	Kurz-Kash, S-345-30
17		PLATE, identification, Tel-A-Scan:	Radiation, 9037-714-19
18	A	KNOB, round, skirted: black (for R744)	Raytheon, 70-2-2
19	J703	CONNECTOR, single contact, male, w/nut:	Switchcraft, 5501MP
20	A	KNOB, round, skirted: black (for R751)	Raytheon, 70-2-2
21	J704	CONNECTOR, single contact, male w/nut:	Switchcraft, 5501MP
22	C	KNOB, pointer, skirted: (for R760)	Raytheon, 70-5-2
23	C	KNOB, pointer, skirted: (for S755)	Raytheon, 70-5-2
24	B	KNOB, round, skirted: red (for S756)	Raytheon, 70-2-2
25	A	KNOB, round, skirted: black (for R826)	Raytheon, 70-2-2
26		PANEL, front, Tel-A-Scan:	Radiation, 9037-711-1

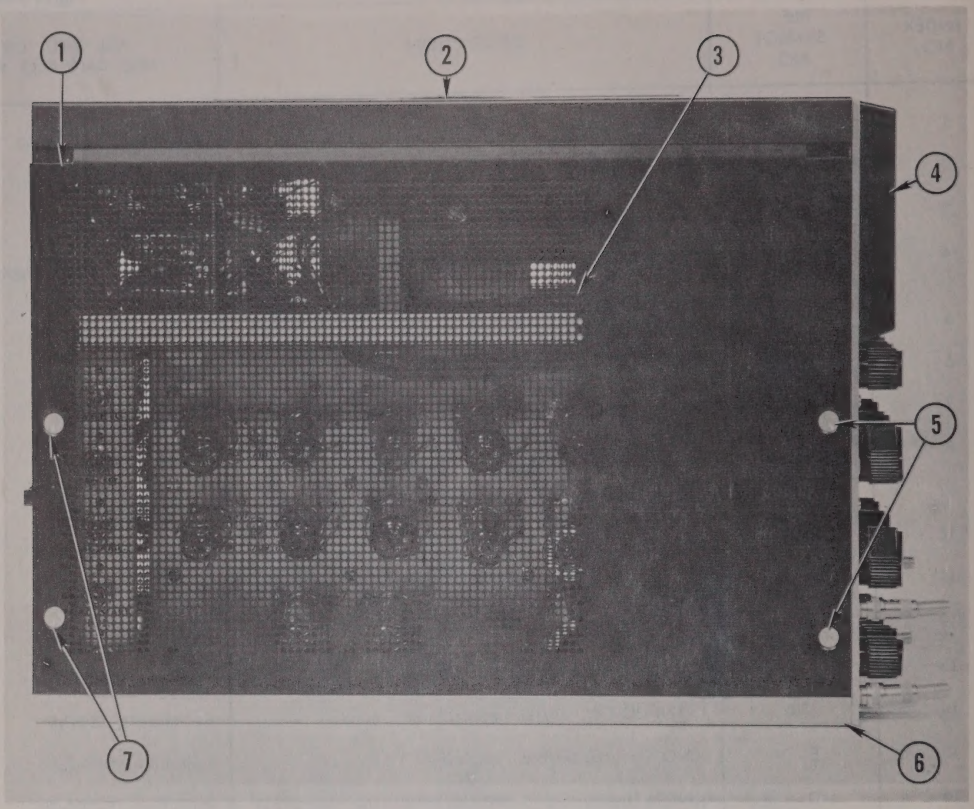


Figure 2-45. Tel-A-Scan Left Side View

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1		COVER, rear:	Radiation, 9037-727-1
2		COVER, top:	Radiation, 9037-341-1
3		COVER, left side:	Radiation, 9037-730-2
4		PANEL, front, control:	See Figure 2-44
5		STUD, airlock: PIN, airlock:	Monadnock-Mills, 98264-2-.130 Monadnock-Mills, 99785-2
6		COVER, bottom:	Radiation, 9037-1310-2
7		STUD, airlock: PIN, airlock:	Monadnock-Mills, 98264-2-.130 Monadnock-Mills, 99785-2

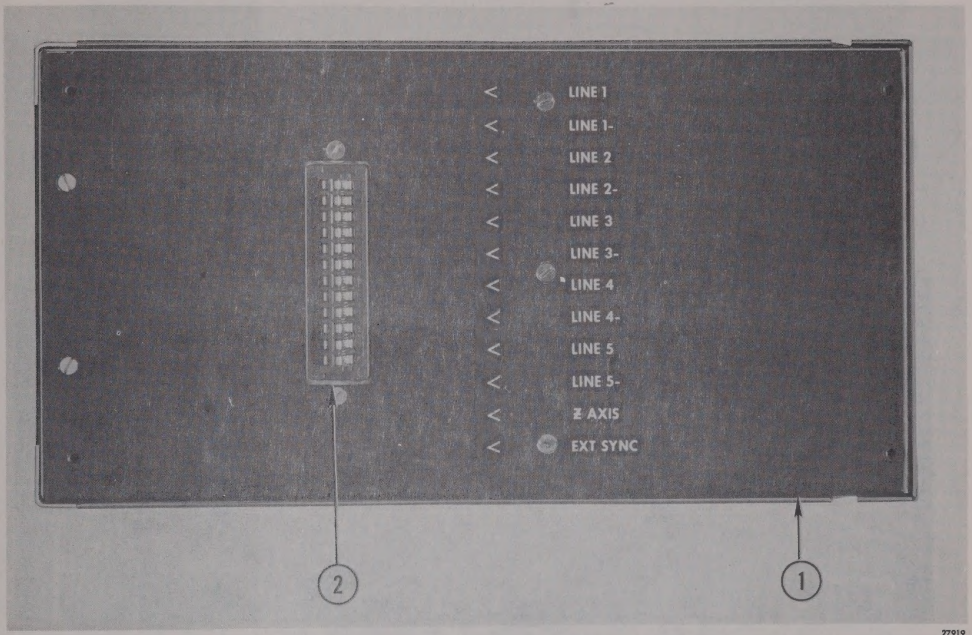
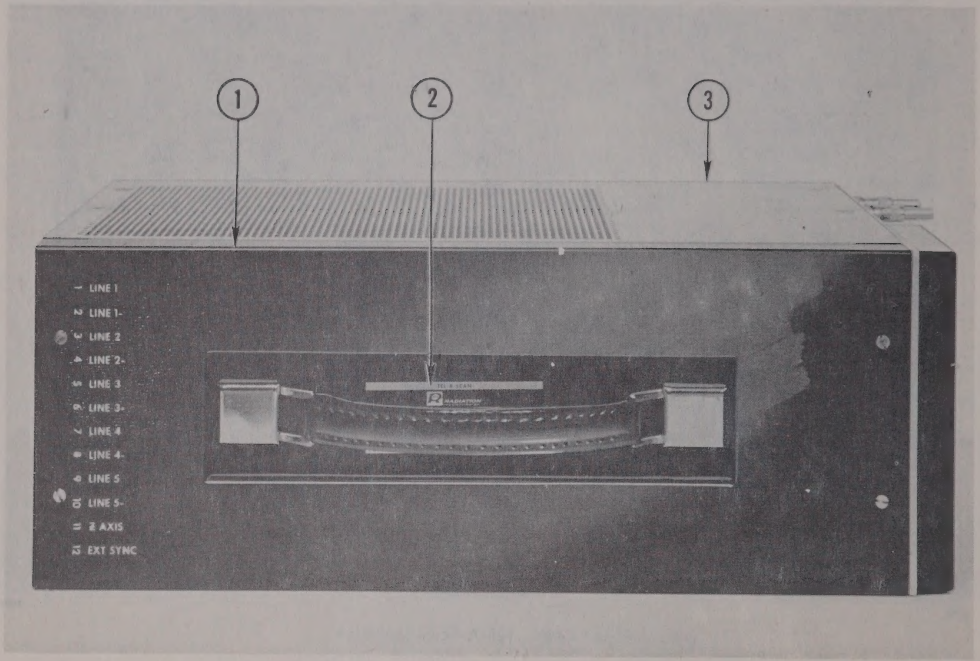


Figure 2-46. Tel-A-Scan Rear View

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1		COVER, rear:	Radiation, 9037-727-1
2		CONNECTOR, plug:	Amphenol, 26-4100-24P



27916

Figure 2-47. Tel-A-Scan Top and Right Side View

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1		COVER, top:	Radiation, 9037-341-1
2		NAMEPLATE:	Radiation, 9037-797-13
3		COVER, right side:	Radiation, 9037-730-1

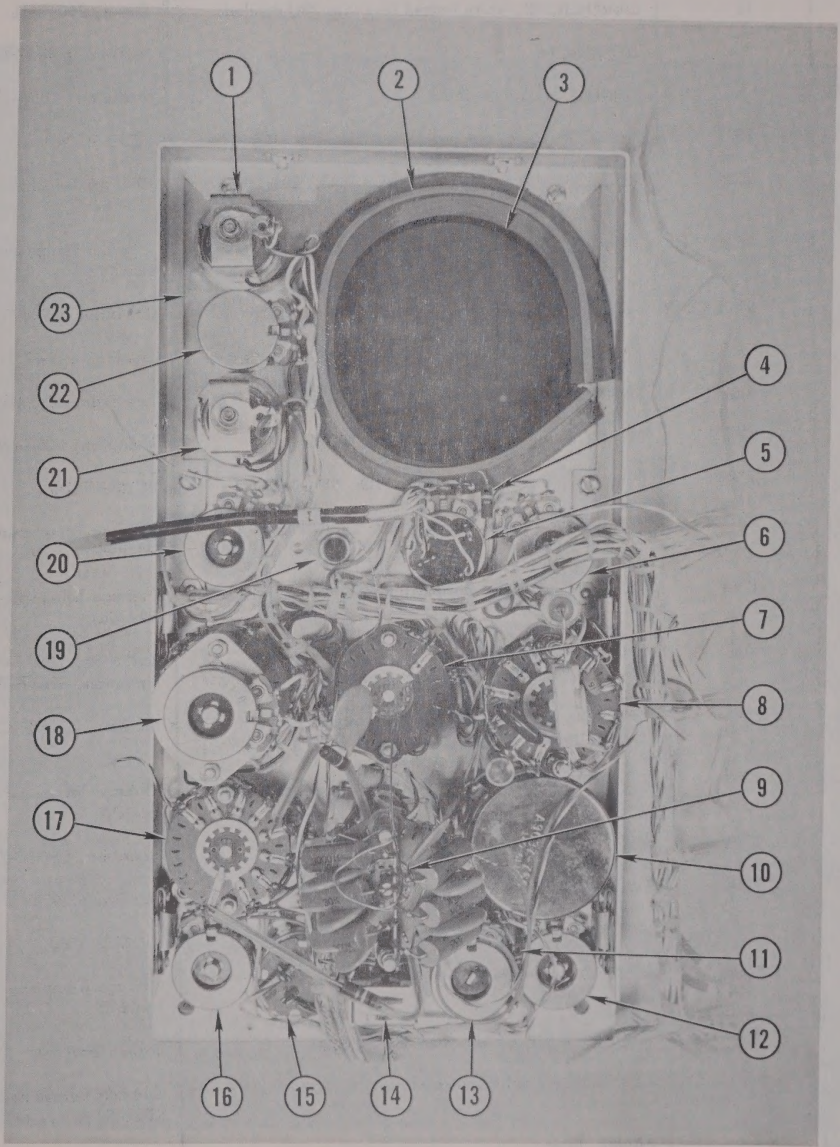


Figure 2-48. Tel-A-Scan Front Panel Interior

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1	I2	LAMPHOLDER, white frosted lens with 28U Bracket:	Drake, 260-1-1L
2		EXTRUSION:	Atlantic India Rubber, X3606
3		GRATICULE, Tel-A-Scan:	Radiation, 9037-739
4	R825	RESISTOR, fixed, composition: 100k, 5%, 1/2w	RC20GF104J
5	R824	RESISTOR, variable, composition: 100k, 20%, 1/3w	Chicago Telephone Supply, HR4102
6	R826	RESISTOR, variable, composition: 500k, 20%, 1/2w	Chicago Telephone Supply, HR4095
7	S753	SWITCH, rotary, sync:	Radiation, C9037-753
8	S755	SWITCH, RANGE:	See Figure 2-49
9	S752	SWITCH, ATTENUATOR:	See Figures 2-51 and 2-52
10	R760	RESISTOR, variable, wire wound: 20k, 5%, 4w	Radiation, 9037-760
11	R745	RESISTOR, fixed, composition: 10k, 5%, 1/2w	RC20GF103J
12	R751	RESISTOR, variable, composition: 500k, 20%, 1/2w	Chicago Telephone Supply, HR4095
13	R744	RESISTOR, variable, composition: 2-100k, 20%, 1/3w	Chicago Telephone Supply, HR4106
14	S751	SWITCH, pushbutton: BRACKET, mounting, pushbutton switch:	Radiation, C9037-751 Radiation, B9037-749
15	R815	RESISTOR, variable, composition: 1k, 10%, W/SPDT switch	Mallory, LC1MPAC
16	R716	RESISTOR, variable, composition: 10k, 20%, 1/2w	Chicago Telephone Supply, HR4094
17	S750	SWITCH, rotary:	Radiation, C9037-750
18	S754	SWITCH, rotary magnifier:	See Figure 2-50
19		BUSHING, chassis w/nut:	UESCO, 1560
20	R779	RESISTOR, variable, composition: 1 meg, 10%	Chicago Telephone Supply, HQ3635
21	I1	LAMPHOLDER, red lens with 28U bracket:	Drake, 260-1-1L
22	R719	RESISTOR, variable, composition: 1k, 10%	Chicago Telephone Supply, KF5725
23		PANEL, front:	Radiation, 9037-711-1

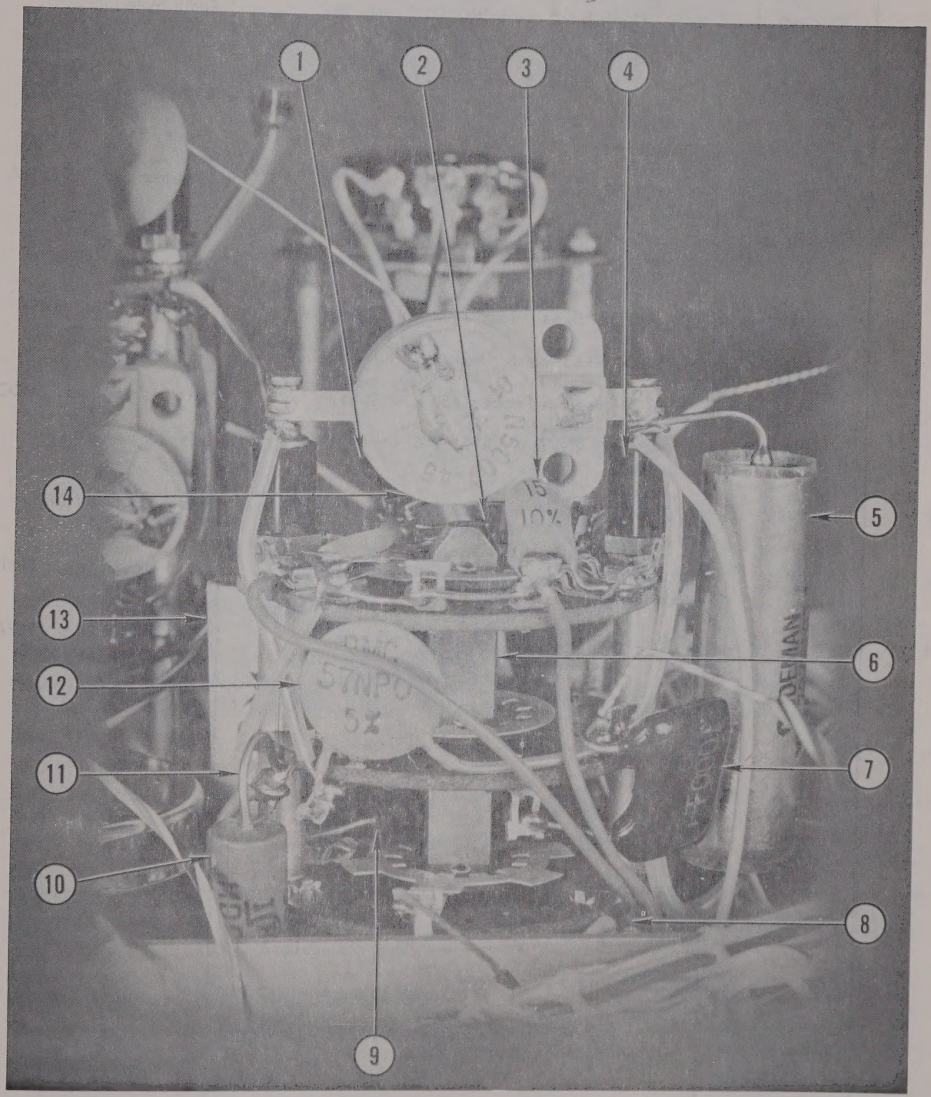


Figure 2-49. Tel-A-Scan RANGE Switch and Components, S755

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1	C755	CAPACITOR, fixed, mica: 1400 mmf, 5%, 500v	Aerovox, ADM-19-142
2	C753	CAPACITOR, fixed, ceramic: 100.0 mmf, 5%	Radio Materials Corp. C100-5/8-N470
3	C752	CAPACITOR, fixed, ceramic: 15.0 mmf, 10%	Radio Materials Corp. C15-1/4-NP0
4		STANDOFF:	Garde, B3449-7HTC
5	C731	CAPACITOR, fixed, polystyrene: 0.01 mf, 1%, 400v	Gademan, XFS727E103A
6	S755	SWITCH, rotary sweep:	Radiation, C9037-755
7	C730	CAPACITOR, fixed, mica: 1000 mmf, 1%, 500v	Aerovox, ADM-19-102
8	C755	CAPACITOR, fixed, mica: 1400 mmf, 5%, 500v	Aerovox, ADM-19-142
9	R758	RESISTOR, fixed, composition: 3.3k, 5%, 1/2w	RC30GF332J
10	R756	RESISTOR, deposited carbon: 500k, 1%, 1/2w	Erie Resistor Corp., MDC
11	C756	CAPACITOR, fixed, mylar film: 0.02 mfd, 5%, 400 vdcw	LT4-203
12	C728	CAPACITOR, fixed, ceramic: 57.0 mmf, 5%	Radio Materials Corp. C57-1/2-NP0
13	C732	CAPACITOR, fixed, mylar, stabilized: 0.1 mfd, 1%, 400v	Plastic Capacitor, LT4-104E
14	C729	CAPACITOR, variable, ceramic: 7-45 mmf	Erie Resistor Corp., TS2AN500

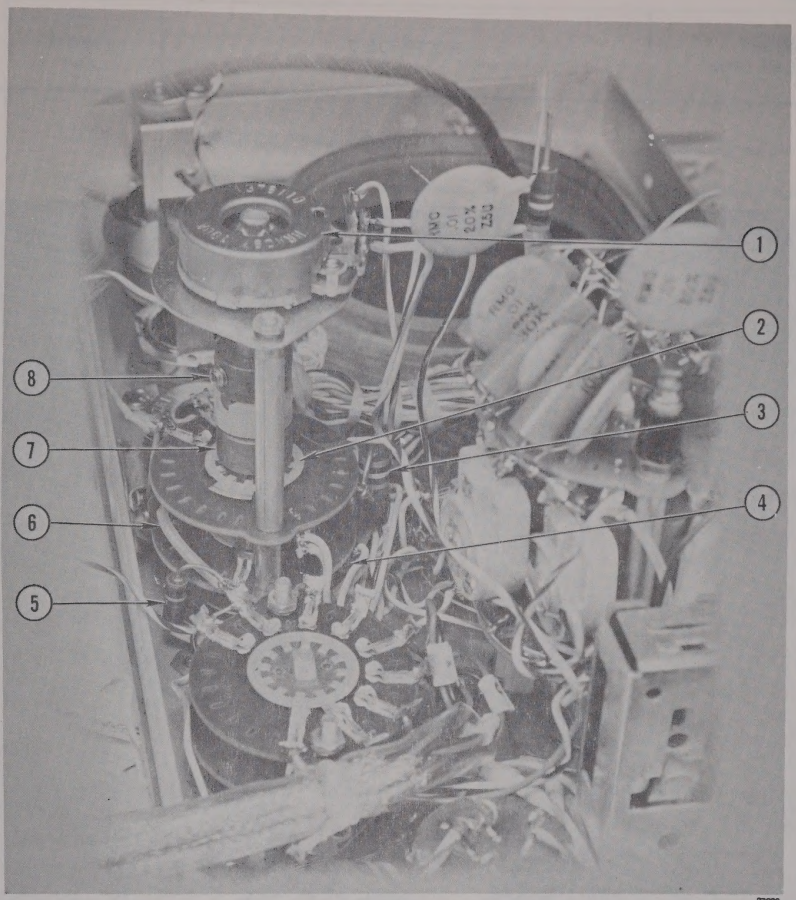


Figure 2-50. Tel-A-Scan MAG POS Switch, S754

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1	R773	RESISTOR, variable, composition: 100k ±20%, 1/3w, 3/8" bushing, 3/4" shaft	Chicago Telephone Supply, HR4097
2	S754	SWITCH, rotary magnifier:	Radiation, C9037-754
3	R765	RESISTOR, fixed, composition: 1w, ±5%, 39k ohms	RC32GF393J
4	R766	RESISTOR, fixed, composition: 1/2w, ±5%, 18k ohms	RC20GF183J
5	R764	RESISTOR, fixed, composition: 1/2w, ±5%, 10k ohms	RC20GF103J
6	R763	RESISTOR fixed, composition: 1/2w, ±5%, 47k ohms	RC32GF473J
7		COUPLING, shaft:	AP1530-4
8		SCREW: 6/32 x 1/8 Allen head, set cup, point (1 not shown)	AN565DC632H2

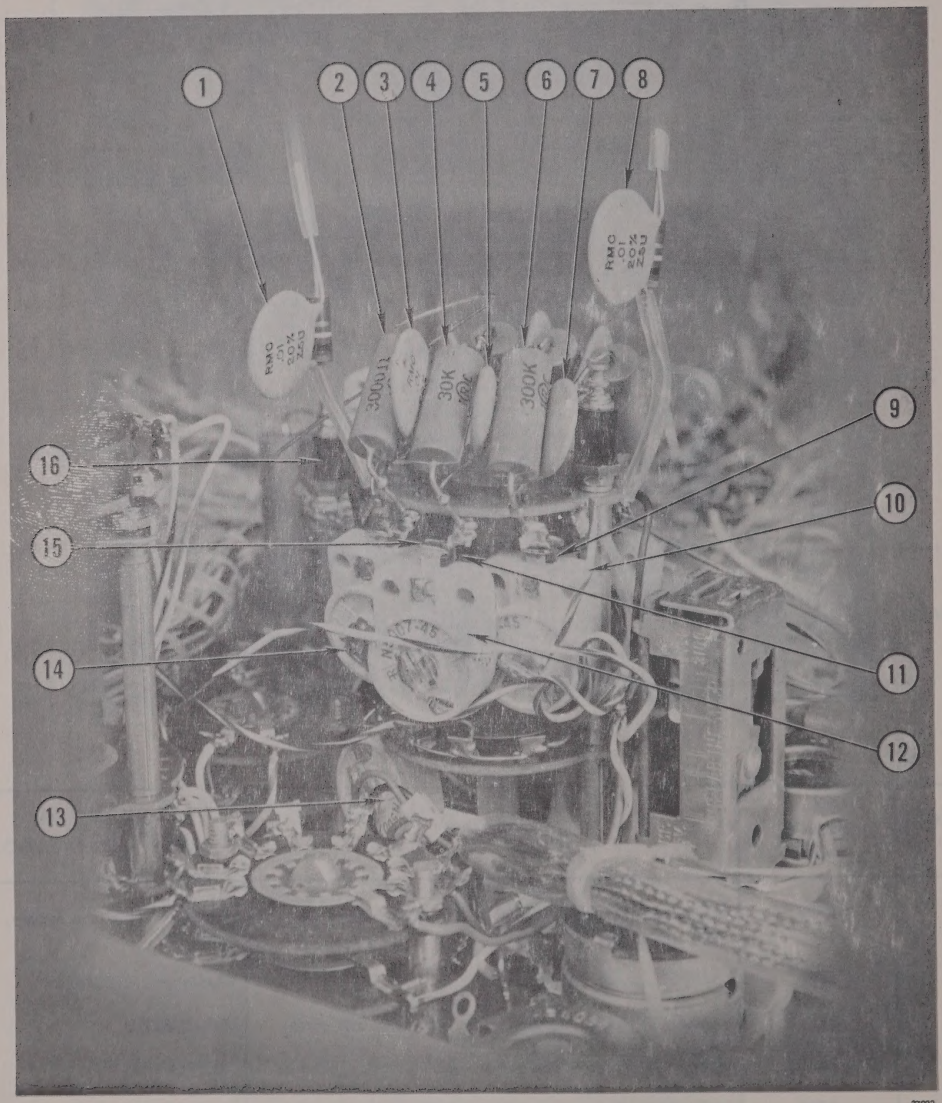


Figure 2-51. Tel-A-Scan ATTENUATOR Switch, S752, Right Side

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1	C717	CAPACITOR, fixed, ceramic: 0.01 mfd, ±20%	Radio Materials Corp., B.01-3/4
2	R706	RESISTOR, fixed, deposited carbon: 3k, ±1%, 1/2w	International Rectifier Corp., MDC
3	C708	CAPACITOR, fixed, ceramic: 0.01 mfd, ±20%	Radio Materials Corp., B.01-3/4
4	R704	RESISTOR, fixed, deposited carbon: 30k, ±1%, 1/2w	International Rectifier Corp., MDC
5	C706	CAPACITOR, fixed, ceramic: 0.001 mfd, ±10%, 1000v	Radio Materials Corp., JL.001-1/2
6	R702	RESISTOR, fixed, deposited carbon: 300k, ±1%, 1/2w	International Rectifier Corp., MDC
7	C704	CAPACITOR, fixed, ceramic: 100 mmf, ±5%	Radio Materials Corp., C100-5/8-N740
8	C718	CAPACITOR, fixed, ceramic: 0.01 mfd, ±20%	Radio Materials Corp., B.01-3/4
9	R701	RESISTOR, fixed, deposited carbon: 2.97 meg, ±1%, 1/2w	International Rectifier Corp., MDC
10	C703	CAPACITOR, variable, ceramic: 7-45 mmf	Erie Resistor Corp., TS2AN500, 7-45 mmf
11	R703	RESISTOR, fixed, deposited carbon: 3.0 meg, ±1%, 1/2w	International Rectifier Corp., MDC
12	C705	CAPACITOR, variable, ceramic: 7-45 mmf,	Erie Resistor Corp., TS2AN500, 7-45 mmf
13	C715	CAPACITOR, variable, ceramic: 7-45 mmf	Erie Resistor Corp., TS2AN500, 7-45 mmf
14	C707	CAPACITOR, variable, ceramic: 7-45 mmf	Erie Resistor Corp., TS2AN500, 7-45 mmf
15	R705	RESISTOR, fixed, deposited carbon: 3.0 meg, ±1%, 1/2w	International Rectifier Corp., MDC
16		STANDOFF:	Garde, B344-7HTC

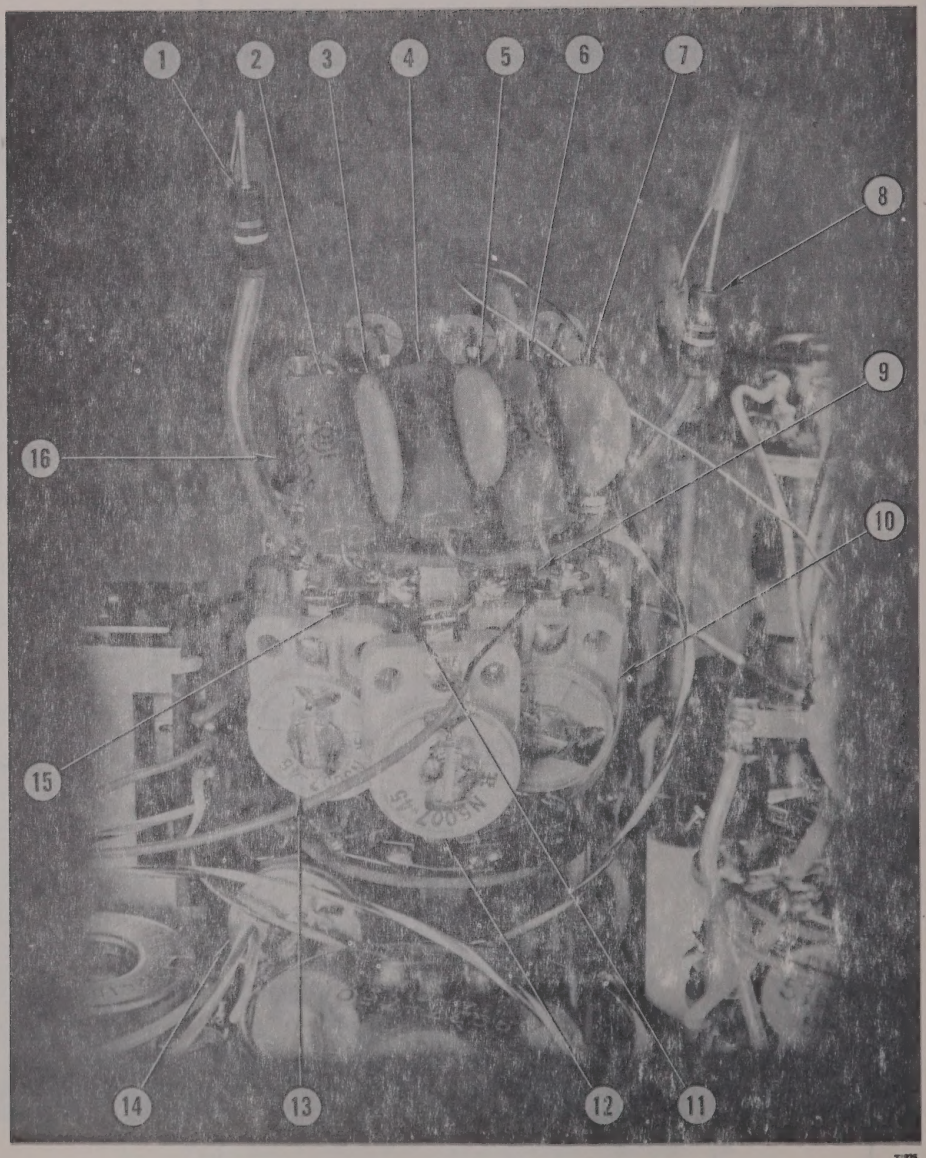


Figure 2-52. Tel-A-Scan ATTENUATOR Switch, S752, Left Side

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1	R714	RESISTOR, fixed, composition: 100k, ±5%, 1/2w	RC20GF104J
2	R712	RESISTOR, fixed, deposited carbon: 3k, ±1%, 1/2w	International Rectifier Corp., MDC
3	C714	CAPACITOR, fixed, ceramic: 0.01 mfd, ±20%	Radio Materials Corp., B.01-3/4
4	R710	RESISTOR, fixed, deposited carbon: 30k, ±1%, 1/2w	International Rectifier Corp., MDC
5	C712	CAPACITOR, fixed, ceramic: 0.001 mfd, ±10%, 1000v	Radio Materials Corp. JL.001-1/2
6	R708	RESISTOR, fixed, deposited carbon: 300k, ±1%, 1/2w	International Rectifier Corp., MDC
7	C710	CAPACITOR, fixed, ceramic: 100 mmf, ±5%	Radio Materials Corp., C100-5/8-N470
8	R713	RESISTOR, fixed, composition: 100k, ±5%, 1/2w	RC20GF104J
9	R707	RESISTOR, fixed, deposited carbon: 2.97 meg, ±1%, 1/2w	International Rectifier Corp., MDC
10	C709	CAPACITOR, variable, ceramic: 7-45 mmf	Erie Resistor Corp., TS2AN500, 7-45 mmf
11	R709	RESISTOR, fixed, deposited carbon: 3 meg, ±1%, 1/2w	International Rectifier Corp., MDC
12	C711	CAPACITOR, variable, ceramic: 7-45 mmf	Erie Resistor Corp., TS2AN500, 7-45 mmf
13	C713	CAPACITOR, variable, ceramic: 7-45 mmf	Erie Resistor Corp., TS2AN500, 7-45 mmf
14	C716	CAPACITOR, variable, ceramic: 7-45 mmf	Erie Resistor Corp., TS2AN500, 7-45 mmf
15	R711	RESISTOR, fixed, deposited carbon: 3 meg, ±1%, 1/2w	International Rectifier Corp., MDC
16		STANDOFF:	Garde, B3449-7HTC

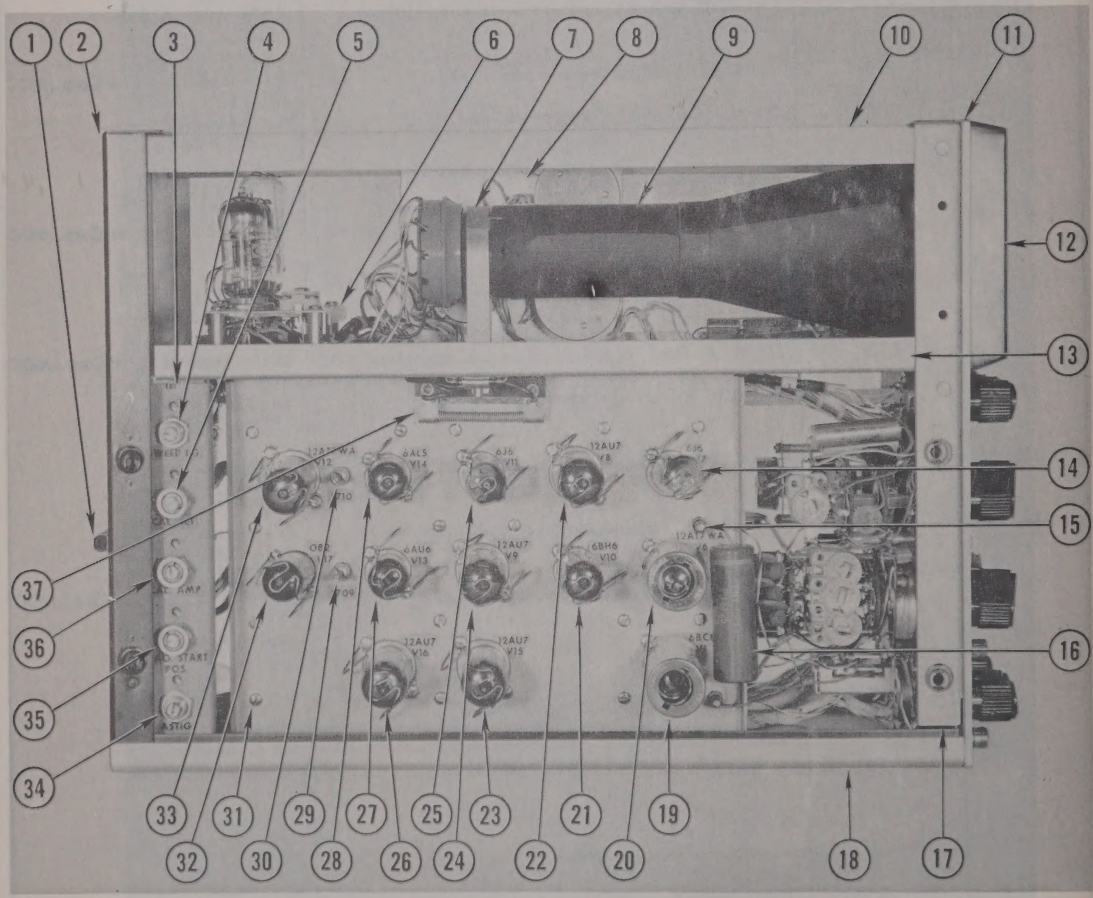


Figure 2-53. Tel-A-Scan Left Side Interior

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1		CONNECTOR:	See Figure 2-46
2		COVER, rear:	See Figure 2-46
3		BRACKET, rear potentiometer: mounting	Radiation, C9037-353
4	R786	RESISTOR, variable, composition: 25k, ±20%, 1/2w, 3/8" bushing, 1/2" slotted shaft	Chicago Telephone Supply, HR4100
5	R818	RESISTOR, variable, composition: 10k, ±10%, 1/2" long slotted shaft, 3/8" bushing with lock nut	Chicago Telephone Supply, FR6648
6		CHASSIS, vertical amplifier:	See Figure 2-55
7		CLAMP, CRT:	Radiation, B9037-705
8		BRACKET, upper potentiometer:	See Figure 2-56
9		TUBE, CRT:	See Figure 2-54
10		BRACE, top support, left side:	Radiation, 9037-110
11		PANEL, control, front:	See Figure 2-44
12		BEZEL:	See Figure 2-44
13		DECK, top, Tel-A-Scan:	Radiation, 9037-761
14	V7	TUBE, electron: CLIP, tube:	6J6 Remler, W73819
15		STANDOFF:	Garde, B-3449-7HTC
16	C702	CAPACITOR, fixed, paper: 0.25 mfd, 20%, 600v	Cornell-Dubilier, CUB-6-P25
17		PANEL LIP, front:	Radiation, 9037-322-3
18		COVER, bottom:	Radiation, 9037-1310-4
19	V1	TUBE, electron: SHIELD:	6BC8 Cinch, TS103U02
20	V6	TUBE, electron: SHIELD:	12AT7WA Cinch, TS103U02
21	V10	TUBE, electron: CLIP, tube:	6BH6 Remler, W73819
22	V8	TUBE, electron: CLIP, tube:	12AU7A Remler, W73819
23	V15	TUBE, electron: CLIP, tube:	12AU7A Remler, W73819
24	V9	TUBE, electron: CLIP, tube:	12AU7A Remler, W73819
25	V11	TUBE, electron: CLIP, tube:	6J6 Remler, W73819

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
26	V16	TUBE, electron: CLIP, tube:	12AU7A Remler, W73819
27	V13	TUBE, electron: CLIP, tube:	6AU6 Remler, W73819
28	V14	TUBE, electron: CLIP, tube:	6AL5 Remler, W73818
29	L709	COIL, peaking:	Radiation, 9037-759
30	L710	COIL, peaking:	Radiation, 9037-759
31		CHASSIS, Tel-A-Scan:	Radiation, D9037-724
32	V17	TUBE, electron: CLIP, tube:	OB2 Remler, W73819
33	V12	TUBE, electron: CLIP, tube:	6J6 Remler, W73819
34	R823	RESISTOR, variable, composition: 1 meg, ±10%, 1/2" long slotted shaft, 3/8" bushing	Chicago Telephone Supply, FR6646
35	R776	RESISTOR, variable, composition: 1 meg, ±20%, 1/4w 3/8" bushing locking type, 1/2" slotted shaft, w/lock nut	Chicago Telephone Supply, HR4105
36	R805	RESISTOR, variable, composition: 100k, ±20%, 1/3w, 3/8" locking type bushing, 1/2" slotted shaft, w/lock nut	Chicago Telephone Supply, HR4104
37		RELAY, thermal, surgistor:	Wurth Tube Saver Corp., 4002-

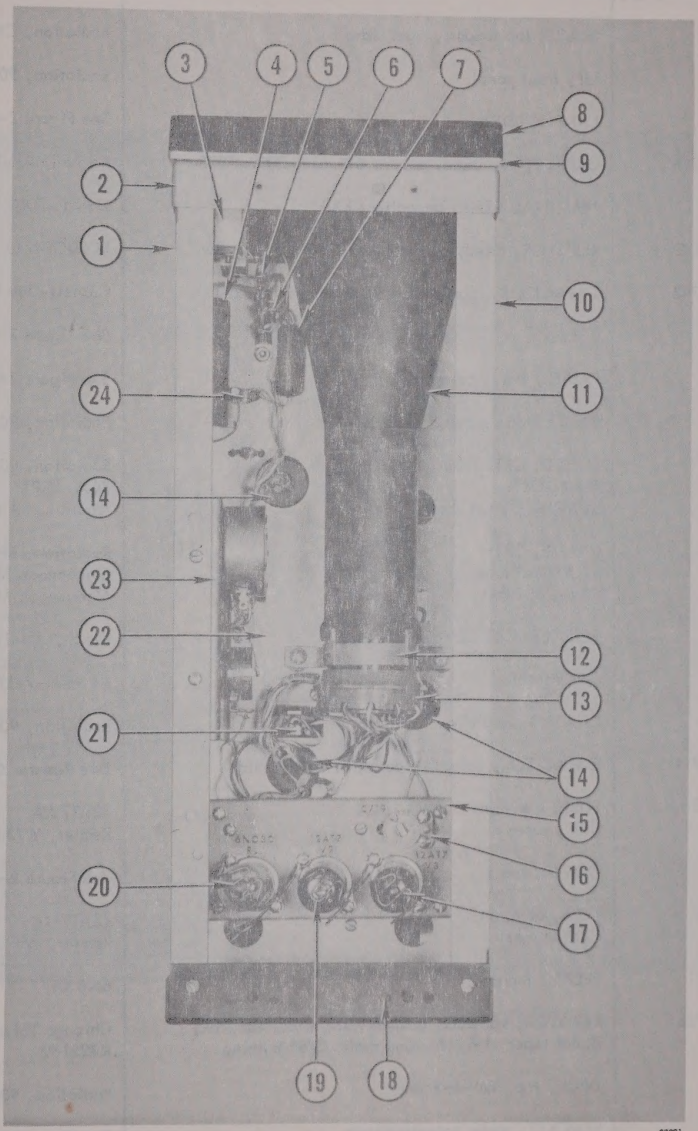


Figure 2-54. Tel-A-Scan Top View Interior

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1		BRACE, top support, right side:	Radiation, C9037-110
2		LIP, front panel:	Radiation, 9037-322-3
3		LAMPHOLDER:	See Figure 2-48
4	C764	CAPACITOR, fixed, paper: 0.1 mfd, 20%, 1000v	Cornell-Dubilier, PJ-10-P1
5		TERMINAL STRIP, phenolic XXXP:	Cinch, 2003
6	R822	RESISTOR, fixed, composition: 470k, 5%, 1/2w	RC20GF474J
7	C742	CAPACITOR, fixed, paper: 0.1 mfd, 20%, 200v	Cornell-Dubilier, CUB-2-P1
8		BEZEL:	See Figure 2-44
9		PANEL, front, control:	See Figure 2-44
10		BRACE, top support, left side:	Radiation, 9037-110
11		SHIELD, CRT, tube: TUBE, CRT: BUMPER (3, not shown)	Radiation, 9037-704 RCA, 3RP1 Atlantic India Rubber, 783
12		CLAMP, CRT: STUDS, airlock: PINS, airlock:	Radiation, B9037-705 Monadnoch Mills, 98293-2-.150 Monadnock Mills, 99785-2
13		SOCKET, CRT tube, duodecal:	Cinch, 3M-12
14		GROMMET:	AN-931-7-11
15		CHASSIS, amplifier, vertical:	Radiation, 9037-763
16	C719	CAPACITOR, variable, ceramic: 7-45 mmfd	Erie Resistor Corp., TS2AN500
17	V3	TUBE, electron: CLIP, tube:	12AT7WA Remler, W73819
18		COVER, rear:	See Figure 2-46
19	V2	TUBE, electron: CLIP, tube:	12AT7WA Remler, W73819
20	RL1	RELAY, thermal:	6N030T
21	R726	RESISTOR, variable, composition: RV2, 10k, 1w, linear taper, 1-9/16" long shaft, 3/8" bushing	Chicago Telephone Supply, KB22189
22		DECK, top, Tel-A-Scan:	Radiation, 9037-761
23		BRACKET, upper potentiometer:	See Figure 2-56
24		STANDOFF, terminal: STANDOFF, terminal (under):	Garde, B3449-7-HTC Garde, B344-4-HTC

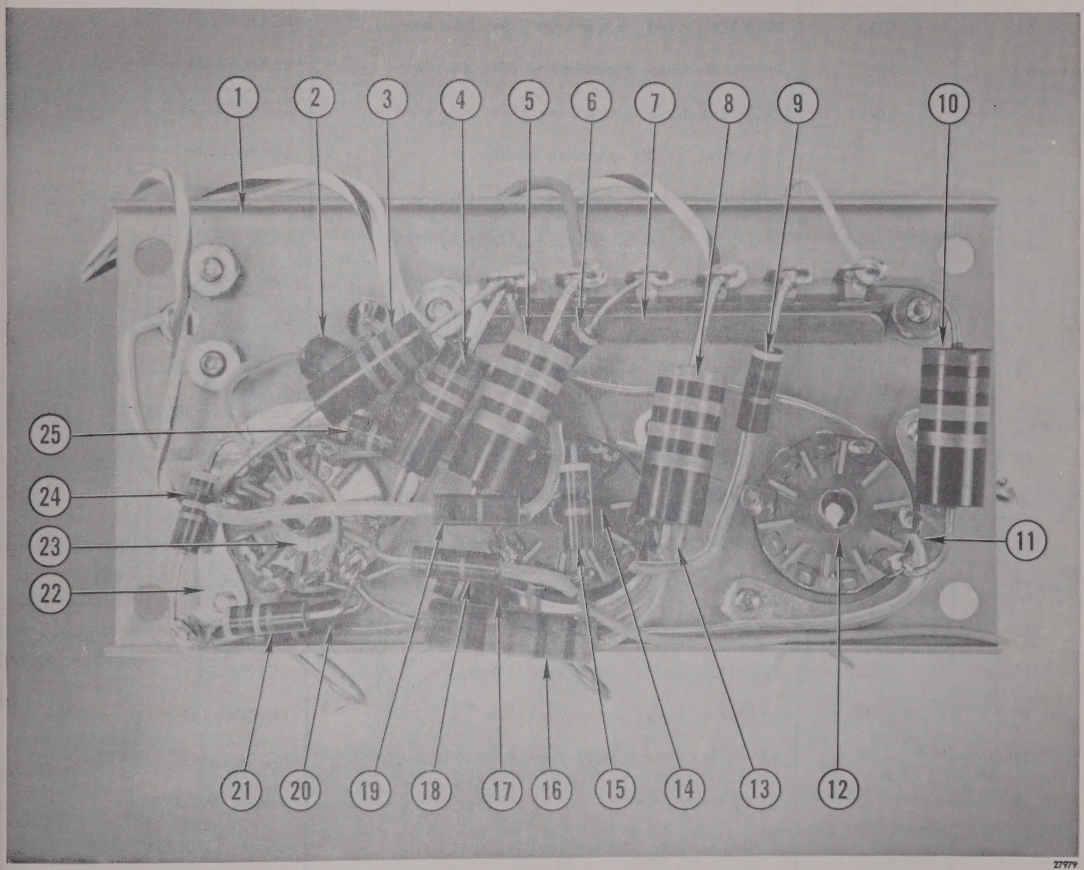


Figure 2-55. Tel-A-Scan Vertical Amplifier

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1		CHASSIS, vertical amplifier:	Radiation, 9037-763
2	C722	CAPACITOR, fixed, ceramic: 120 mmfd, ±5%	Erie Resistor Corp., N750L120
3	R733	RESISTOR, fixed, composition: 56k, 5%, 1w	RC32GF563J
4	R732	RESISTOR, fixed, composition: 56k, 5%, 1w	RC32GF563J
5	R725	RESISTOR, fixed, composition: 33k, 5%, 2w	RC42GF333J
6	R721	RESISTOR, fixed, composition: 47k, 5%, 1/2w	RC20GF470J
7		TERMINAL STRIP: phenolic XXXP	Cinch, 2006
8	R724	RESISTOR, fixed, composition: 33k, 5%, 2w	RC42GF333J
9	R720	RESISTOR, fixed, composition: 47k, 5%, 1/2w	RC20GF470J
10	R723	RESISTOR, fixed, composition: 18k, 5%, 2w	RC42GF183J
11		CLIP, tube:	Remler, W73819
12	RL1	SOCKET, tube: 9-pin, miniature, 9AM	Cinch, TS103P02
13		CLIP, tube:	Remler, W73819
14	V2	SOCKET, tube: 9-pin, miniature, 9AM	Cinch, TS103P02
15	R834	RESISTOR, fixed, composition: 47k, 5%, 1/2w	RC20GF470J
16	C721	CAPACITOR, fixed, ceramic: 120 mmfd, ±5%	Erie Resistor Corp., N750L120
17	R727	RESISTOR, fixed, composition: 470k, 5%, 1/2w	RC20GF474J
18	R734	RESISTOR, fixed, composition: 1 meg, 5%, 1/2w	RC20GF105J
19	R735	RESISTOR, fixed, composition: 1 meg, 5%, 1/2w	RC20GF105J
20	R731	RESISTOR, fixed, composition: 12k, 5%, 1/2w	RC20GF123J
21	R729	RESISTOR, fixed, composition: 470k, 5%, 1/2w	RC20GF474J
22		CLIP, tube:	Remler, W73317
23	V3	SOCKET, tube: 9-pin, miniature, 9AM	Cinch, TS103P02
24	R730	RESISTOR, fixed, composition: 470k, 5%, 1/2w	RC20GF474J
25	R728	RESISTOR, fixed, composition: 470k, 5%, 1/2w	RC20GF474J

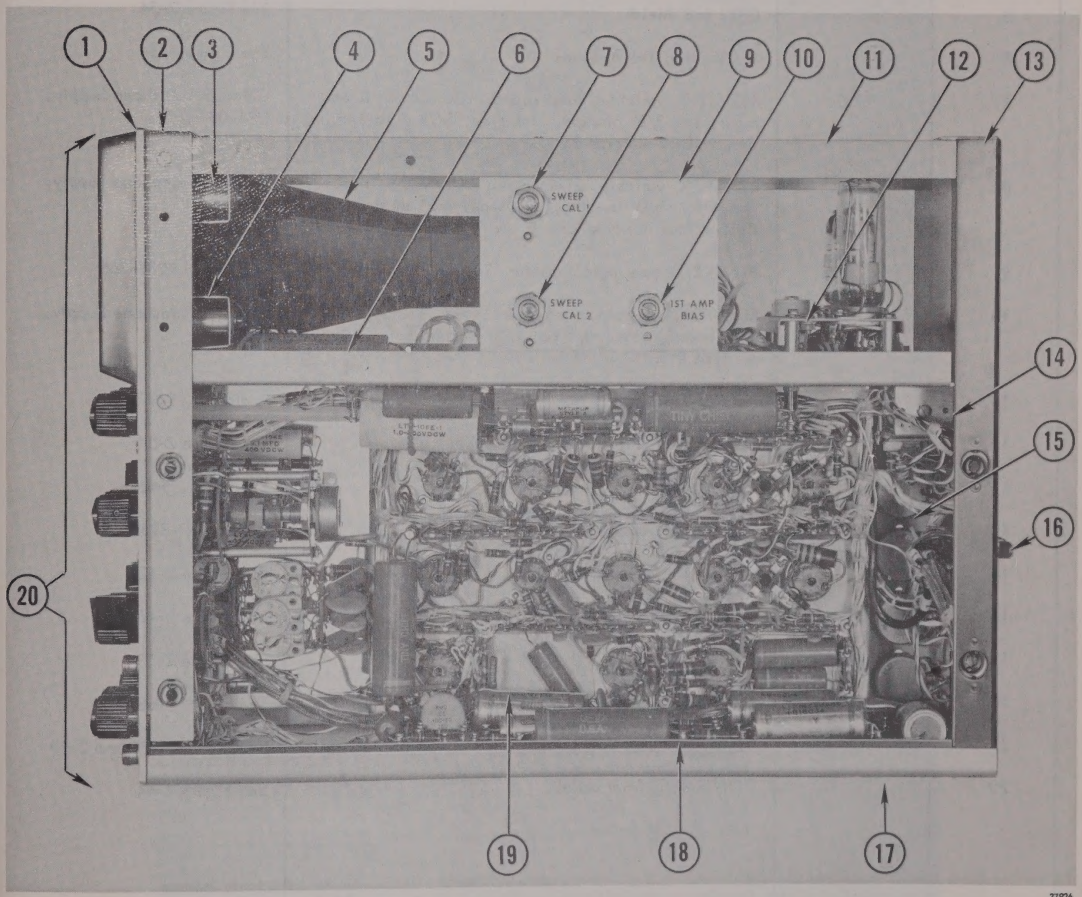


Figure 2-56. Tel-A-Scan Right Side Interior

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1		PANEL, front:	See Figure 2-44
2		PANEL LIP, front:	Radiation 9037-322-3
3		LAMPHOLDER:	See Figure 2-48
4		LAMPHOLDER:	See Figure 2-48
5		CRT, and shield:	See Figure 2-54
6		DECK, top, Tel-A-Scan:	See Figure 2-54
7	R759	RESISTOR, variable, wire wound: 20k, +20%, linear taper, 4w, 3/8" bushing, lock type, 1/2" shaft w/screw slot, w/lock nut type 25	Chicago Telephone Supply, HR4108
8	R761	RESISTOR, variable, wire wound: 20k, +20%, linear taper, 4w, 3/8" bushing, lock type, 1/2" shaft w/screw slot, w/lock nut type 25	Chicago Telephone Supply, HR4108
9		BRACKET, upper potentiometer, Tel-A-Scan:	Radiation, 9037-765
10	R722	RESISTOR, variable, composition: 10k, +10%, 1w, 3/8" bushing, locking type, 1/2" slotted shaft, w/lock nut type RV2	Chicago Telephone Supply, KI22229
11		BRACE, top support, right side:	Radiation, 9037-130
12		AMPLIFIER, vertical:	See Figure 2-54
13		COVER, rear:	See Figure 2-46
14		RELAY: 6.3 vac, 4PST	Aemco, 83-3939
15		BRACKET, rear potentiometer:	See Figure 2-53
16		CONNECTOR:	See Figure 2-46
17		COVER, bottom:	See Figure 2-53
18	TB30	TERMINAL BOARD:	See Figure 2-58
19		CHASSIS, main, Tel-A-Scan:	See Figures 2-59 and 2-57
20		CONTROLS, front panel:	See Figure 2-44

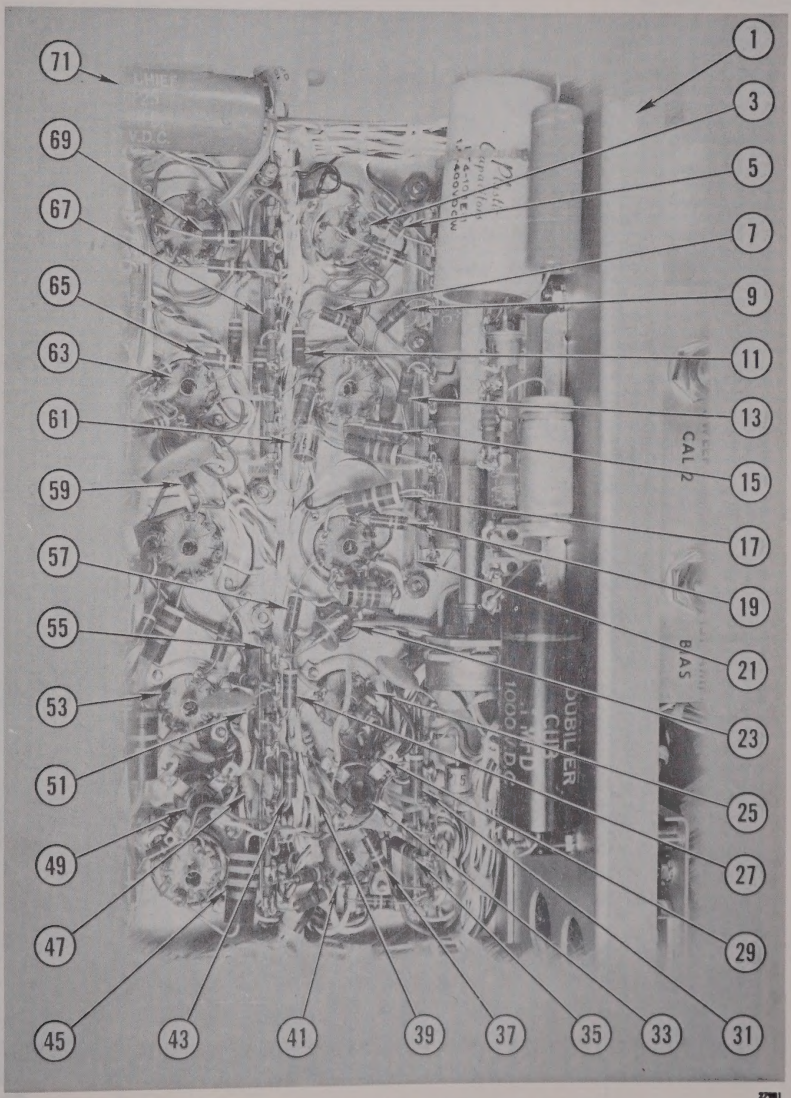


Figure 2-57. Tel-A-Scan Main Chassis, Upper Half

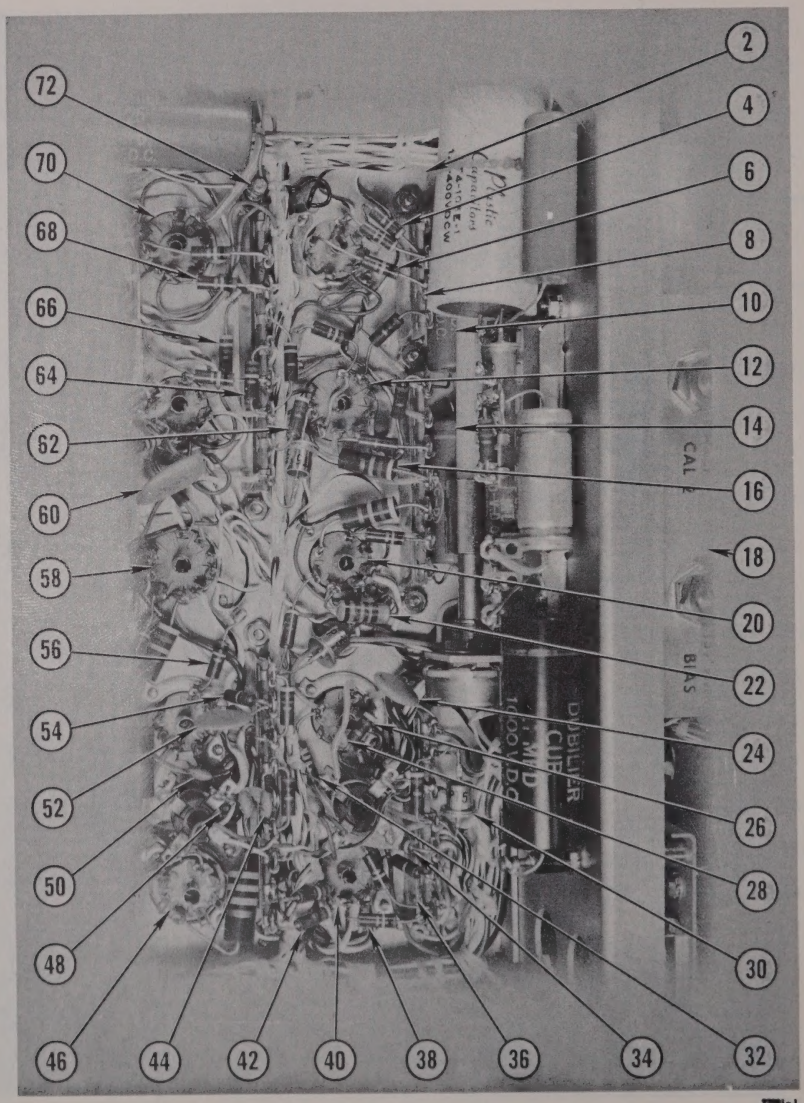


Figure 2-57. Tel-A-Scan Main Chassis, Upper Half

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1		DECK, top:	See Figure 2-53
2		CHASSIS, main, Tel-A-Scan:	Radiation, D9037-724
3	XV7	SOCKET, tube: 7-pin, miniature, 7AM	Cinch, TS103P02
4	R740	RESISTOR, fixed, composition: 47k, 5%, 1/2w	RC20GF473J
5	R739	RESISTOR, fixed, composition: 47k, 5%, 1/2w	RC20GF473J
6	R741	RESISTOR, fixed, composition: 100k, 5%, 1/2w	RC20GF104J
7	R747	RESISTOR, fixed, composition: 56k, 5%, 1/2w	RC20GF563J
8	TP1 (tie point)	TERMINAL STRIP: phenolic, XXXP	Cinch, 2004
9	R742	RESISTOR, fixed, composition: 1.5m, 5%, 1/2w	RC20GF155J
10	C725	CAPACITOR, fixed, paper: 0.1 mfd, 20%, 400v	Cornell-Dubilier, CUB-4-P1
11	R753	RESISTOR, fixed, composition: 3.3m, 5%, 1/2w	RC20GF335J
12	XV8	SOCKET, tube: 9-pin, miniature, 9AM	Cinch, TS103P02
13	R738	RESISTOR, fixed, composition: 1.5m, 5%, 1/2w	RC20GF155J
14	C726	CAPACITOR, fixed, paper: 0.1 mfd, 20%, 400v	Cornell-Dubilier, CUB-4-P1
15	R833	RESISTOR, fixed, composition: 2.2k, 5%, 1/2w	RC20GF222J
16	R746	RESISTOR, fixed, composition: 47k, 5%, 1w	RC32GF473J
17	R770	RESISTOR, fixed, composition: 47k, 5%, 1w	RC32GF473J
18		BRACKET, upper potentiometer:	See Figure 2-56
19	R771	RESISTOR, fixed, composition: 10k, 5%, 1/2w	RC20GF103J
20	XV11	SOCKET, tube: 7-pin, miniature, 7AM	Cinch, TS102P02
21	TP2 (tie point)	TERMINAL STRIP: phenolic XXXP	Cinch, 2007
22	C737	CAPACITOR, fixed, ceramic, 150 mmf, 20%, 500v	Erie Resistor Corp., GP2K150
23	CR702	DIODE:	Radio Receptor, PT5
24	C766	CAPACITOR, fixed, ceramic: 0.001 mmf, 10%, 1000v	Radio Materials Corp., JL.001-1/2
25	XV14	SOCKET, tube: 7-pin, miniature, 7AM	Cinch, TS102P02
26	R829	RESISTOR, fixed, composition: 4.7m, 5%, 1/2w	RC20GF475J
27	R768	RESISTOR, fixed, composition: 4.7m, 5%, 1/2w,	AB, Type EB
28	C749	CAPACITOR, fixed, ceramic: 47 mmf, 20%, 1000v	Radio Materials Corp., C47-1/4-N1500
29	R820	RESISTOR, fixed, composition: 470k, 5%, 1/2w	RC20GF474J
30	CR705	DIODE:	Radio Receptor, PT5

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
31	R819	RESISTOR, fixed, composition: 4.7m, 5%, 1/2w	RC20GF475J
32	R798	RESISTOR, fixed, composition: 33k, 5%, 1/2w	RC20GF333J
33	L710	COIL, peaking:	Radiation, 9037-759
34	R782	RESISTOR, fixed, composition: 47, 5%, 1/2w	RC20GF470J
35	R784	RESISTOR, fixed, composition: 180k, 5%, 1/2w	RC20GF184J
36	TP3 (tie point)	TERMINAL STRIP: XXXP, phenolic	Cinch, 2007
37	R787	RESISTOR, fixed, composition: 100k, 5%, 1/2w	RC20GF104J
38	R788	RESISTOR, fixed, composition: 100k, 5%, 1/2w	RC20GF104J
39	C748	CAPACITOR, fixed, ceramic: 15.0 mmf, 10%	Radio Materials Corp., C15-1/4-NP0
40	XV12	SOCKET, tube: 9-pin, miniature, 9AM	Cinch, TS103P02
41	R785	RESISTOR, fixed, composition: 180k, 5%, 1/2w	RC20GF184J
42	R783	RESISTOR, fixed, composition: 47, 5%, 1/2w	RC20GF470J
43	R828	RESISTOR fixed, composition: 1.5m, 5%, 1/2w	RC20GF155J
44	C767	CAPACITOR, fixed, ceramic: 47 mmf, 20%, 1000v	Radio Materials Corp., C47-1/4-N1500
45	R807	RESISTOR, fixed, composition: 33k, 5%, 2w	RC42GF333J
46	XV17	SOCKET, tube: 7-pin, miniature, 7AM	Cinch, TS102P02
47	C746	CAPACITOR, fixed, ceramic: 47 mmf, 20%, 1000v	Radio Materials Corp., C47-1/4-N1500
48	C747	CAPACITOR, fixed, ceramic: 0.150 mmf, 20%, 500v, $\pm$20%	Erie Resistor Corp., GP2K150
49	L709	COIL, peaking:	Radiation, 9037-759
50	C745	CAPACITOR, fixed, ceramic: 47 mmf, 20%, 1000v	Radio Materials Corp., C47-1/4-N1500
51	R794	RESISTOR, fixed, composition: 470k, 5%, 1/2w	RC20GF474J
52	C744	CAPACITOR, fixed, ceramic, disc: 100 mmf, 5%, 1000v	Radio Materials Corp., C100-5/8
53	XV13	SOCKET, tube: 7-pin, miniature, 7AM	Cinch, TS102P02
54	R793	RESISTOR, fixed, composition: 270k, 5%, 1/2w	RC20GF274J
55	TP5 (tie point)	TERMINAL STRIP: XXXP, phenolic	Cinch, 2009
56	R795	RESISTOR, fixed, composition: 10k, 5%, 1/2w	RC20GF103J
57	R767	RESISTOR, fixed, composition: 470, 5%, 1/2w	RC20GF471J

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
58	XV9	SOCKET, tube: 9-pin, miniature, 9AM	Cinch, TS103P02
59	R750	RESISTOR, fixed, composition: 470k, 5%, 1/2w	RC20GF474J
60	C765	CAPACITOR, fixed, ceramic: 0.05 mfd, -20%, +80%, 500v	Radio Materials Corp., B.05-3/4
61	CR701	DIODE:	Radio Receptor, PT5
62	R748	RESISTOR, fixed, composition: 470, 5%, 1/2w	RC20GF471J
63	XV10	SOCKET, tube: 7-pin, miniature, 7AM	Cinch, TS102P02
64	R752	RESISTOR, fixed, composition: 180k, 5%, 1/2w	RC20GF184J
65	R762	RESISTOR, fixed, composition: 100k, 5%, 1/2w	RC20GF104J
66	R834	RESISTOR, fixed, composition: 330, 5%, 1/2w	RC20GF331J
67	TP4 (tie point)	TERMINAL STRIP: XXXP, phenolic	Cinch, 2009
68	R736	RESISTOR, fixed, composition: 10k, 5%, 1/2w	RC20GF103J
69	R737	RESISTOR, fixed, composition: 100k, 5%, 1/2w	RC20GF104J
70	XV6	SOCKET, tube: 9-pin, miniature	Cinch, TS103P01
71	C701	CAPACITOR, fixed, paper: 0.25 mfd, 20%, 600v	Cornell-Dubilier, CUB-6-P25
72		STANDOFF:	Garde, B-3449-4HTC

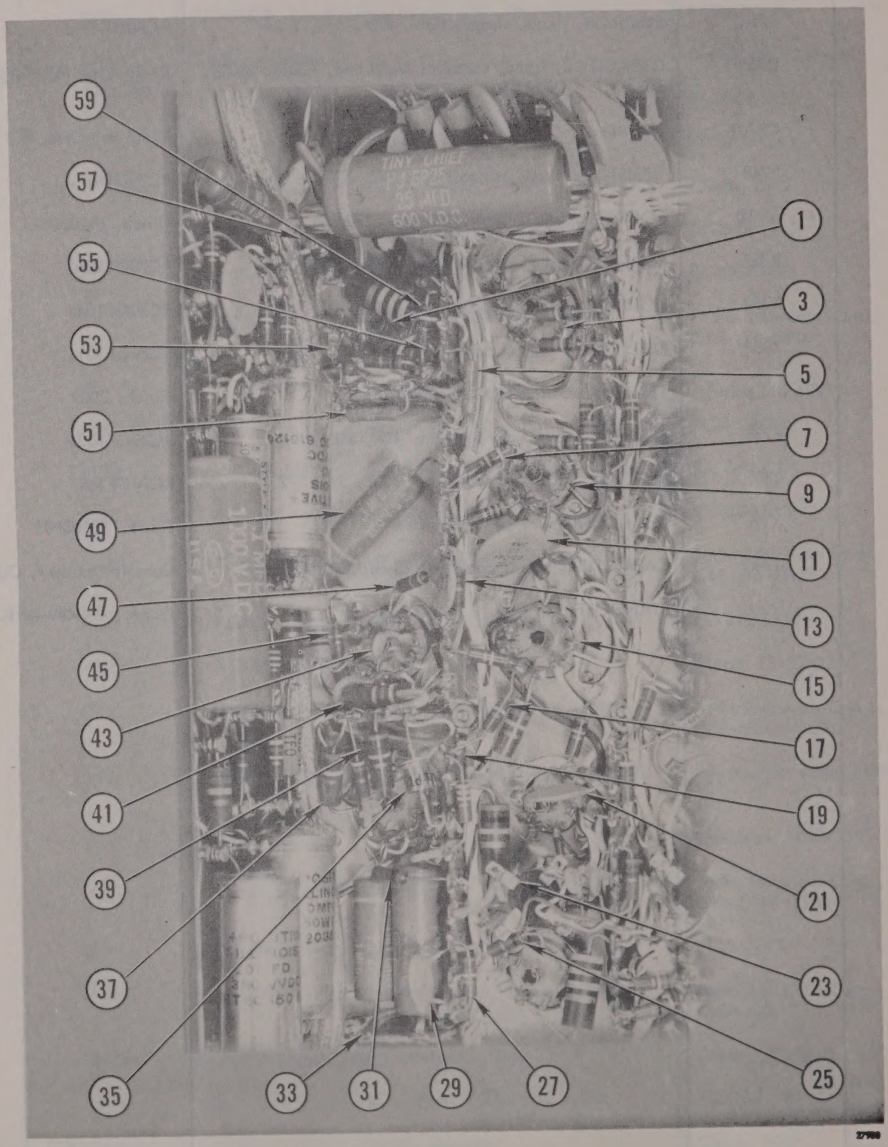


Figure 2-58. Tel-A-Scan Main Chassis, Lower Half

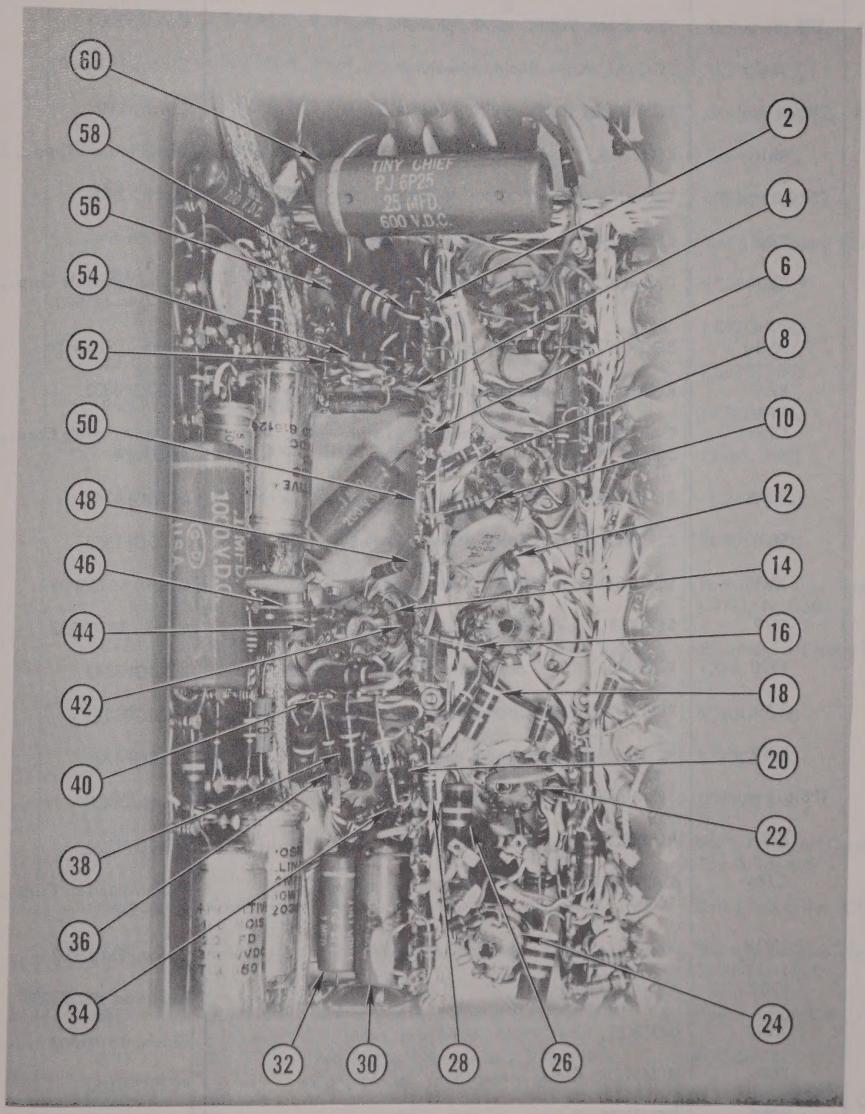


Figure 2-58. Tel-A-Scan Main Chassis, Lower Half

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1	XV1	SOCKET, tube: 9-pin, miniature	Cinch, TS103P01
2	TP6 (tie point)	TERMINAL STRIP: XXXP, phenolic	Cinch, 2003
3	XV6	SOCKET, tube: 9-pin, miniature	Cinch, TS103P01
4	TP9 (tie point)	TERMINAL STRIP: XXXP, phenolic	Cinch, 2003
5	R816	RESISTOR, fixed, deposited carbon: 1k, 1%, 1/2w	Dale Products Corp., DCS-1/2
6	TP7 (tie point)	TERMINAL STRIP: XXXP, phenolic	Cinch, 2009
7	R754	RESISTOR, fixed, composition: 470k, 5%, 1/2w	RC20GF474J
8	C734	CAPACITOR, fixed, ceramic: 47 mmf, 20%, 1000v	Radio Materials Corp., C47-1/4-N1500
9	XV10	SOCKET, tube: 7-pin, miniature, 7AM	Cinch, TS102P02
10	R757	RESISTOR, fixed, composition: 33k , 5%, 1/2w	RC20GF333J
11	C765	CAPACITOR, fixed, ceramic: 0.05 mfd, -20%, +80%, 500v	Radio Materials Corp., B.05-3/4
12	R750	RESISTOR, fixed, composition: 470k, 5%, 1/2w	RC20GF474J
13	R801	RESISTOR, fixed, composition: 1.5m, 5%, 1/2w	RC20GF155J
14	XV15	SOCKET, tube: 9-pin, miniature, 9AM	Cinch, TS103P02
15	XV9	SOCKET, tube: 9-pin, miniature, 9AM	Cinch, TS103P02
16	R790	RESISTOR, fixed, composition: 820k, 5%, 1/2w	RC20GF824J
17	R791	RESISTOR, fixed, composition: 820k, 5%, 1/2w	RC20GF824J
18	R792	RESISTOR, fixed, composition: 47k, 5%, 1/2w	RC20GF473J
19	TP8 (tie point)	TERMINAL STRIP: XXXP, phenolic	Cinch, 2009
20	R796	RESISTOR, fixed, composition: 1.2k, 5%, 1/2w	RC20GF122J
21	C744	CAPACITOR, fixed, ceramic, disc: 100 mmf, 5%, 1000v	Radio Materials Corp., C100-5/8
22	XV13	SOCKET, tube: 7-pin, miniature, 7AM	Cinch, TS102P02
23	L709	COIL, peaking:	Radiation, 9037-759
24	XV17	SOCKET, tube: 7-pin, miniature, 7AM	Cinch, TS102P02
25	R806	RESISTOR, fixed, composition: 1m, 5%, 1/2w	RC20GF105J
26	R797	RESISTOR, fixed, composition: 10k, 5%, 2w	RC42GF103J
27	R821	RESISTOR, fixed, composition: 820k, 5%, 1/2w	RC20GF824J
28	R809	RESISTOR, fixed, composition: 330k, 5%, 1/2w	RC20GF334J

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
29	C763	CAPACITOR, fixed, ceramic, disc: 60 mmf, 10%, 1000v	Radio Materials Corp., C60-5116NP0
30	C758	CAPACITOR, fixed, paper: 0.1 mf, 20%, 400v	Cornell-Dubilier, CUB-4-P1
31	R811	RESISTOR, fixed, composition: 1m, 5%, 1/2w	RC20GF105J
32	C760	CAPACITOR, fixed, paper: 0.1 mfd, 20%, 200v	Cornell-Dubilier, CUB-2-P1
33	TP11 (tie point)	TERMINAL STRIP: XXXP, phenolic	Cinch, 2003
34	R814	RESISTOR, fixed, composition: 1k, 5%, 1/2w	RC20GF102J
35	CR704	DIODE:	Radio Receptor, PT5
36	R812	RESISTOR, fixed, composition: 4.7m, 5%, 1/2w	RC20GF475J
37	R813	RESISTOR, fixed, composition: 150k, 5%, 1w	RC32GF154J
38	R810	RESISTOR, fixed, composition: 15k, 5%, 1w	RC32GF153J
39	R808	RESISTOR, fixed, composition: 47k, 5%, 1/2w	RC20GF473J
40	TP10 (tie point)	TERMINAL STRIP: XXXP, phenolic	Cinch, 2003
41	R804	RESISTOR, fixed, composition: 47k, 5%, 1w	RC32GF473J
42	R800	RESISTOR, fixed, composition: 22k, 5%, 1/2w	RC20GF223J
43	C757	CAPACITOR, fixed, ceramic: 47 mmf, 20%, 1000v	Radio Materials Corp., C47-1/4-N1500
44	C723	CAPACITOR, fixed, ceramic: 470 mmf, 20%, 500v	Erie Resistor Corp., GP2K-470 ±20%
45	R802	RESISTOR, fixed, composition: 5.6k, 5%, 1/2w	RC20GF562J
46	R803	RESISTOR, fixed, composition: 150k, 5%, 1/2w	RC20GF154J
47	R799	RESISTOR, fixed, composition: 47k, 5%, 1/2w	RC20GF473J
48	C751	CAPACITOR, fixed, ceramic: 60.0 mmf, 5%, 1000v	Radio Materials Corp., C60-5/16-NP0
49	C739	CAPACITOR, fixed, paper: 0.1 mfd, 20%, 200v	Cornell-Dubilier, CUB-2-P1
50	C750	CAPACITOR, fixed, ceramic: 6.8 mmf, 10%	Radio Materials Corp., C6.8-1/4-N470
51	R817	RESISTOR, fixed, deposited carbon: 1k, 1%, 1/2w	Dale Products Corp., DCS-1/2
52	R718	RESISTOR, fixed, composition: 2.2k, 1/2w, ±5%	RC20GF222J
53	CR707	DIODE:	General Transistor, GTD976
54	R836	RESISTOR, fixed, composition: 1k, 5%, 1/2w	RC20GF102J
55	CR706	DIODE:	General Transistor, GTD976
56	R837	RESISTOR, fixed, composition: 33k, 5%, 1w	RC32GF333J

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
57		STANDOFF:	Garde, B3449-4-HTC
58	R717	RESISTOR, fixed, composition: 2.2k, 5%, 1/2w	RC20GF222J
59	R835	RESISTOR, fixed, composition: 1k, 5%, 1/2w	RC20GF102J
60	C701	CAPACITOR, fixed, paper: 0.25 mfd, 20%, 600v	Cornell-Dubilier, CUB-6-P25

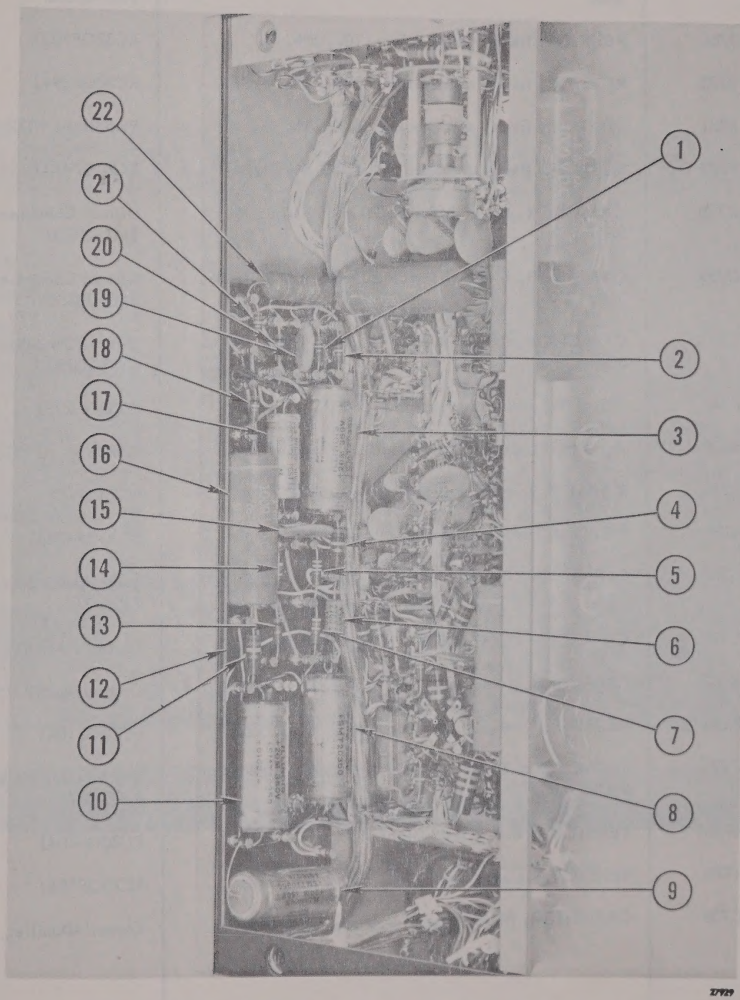


Figure 2-59. Tel-A-Scan Terminal Board TB30

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1	R774	RESISTOR, fixed, composition: 270k, 5%, 1/2w	RC20GF274J
2	R827	RESISTOR, fixed, composition: 470k, 5%, 1/2w	RC20GF474J
3	C736	CAPACITOR, fixed, electro: 20 mfd, -10%, +50%, 350v	Illinois Condenser Corp., SMT-20350
4	R769	RESISTOR, fixed, composition: 10k, 5%, 1w	RC32GF103J
5	R772	RESISTOR, fixed, composition: 390k, 5%, 1/2w	RC20GF394J
6	R831	RESISTOR, fixed, wire wound: 2.7k, 5%, 3w	Radiation, 9037-1372, Series 88
7	R777	RESISTOR, fixed, composition: 470k, 5%, 1/2w	RC20GF474J
8	C770	CAPACITOR, fixed, electro: 20 mfd, -10%, +50%, 350v	Illinois Condenser Corp., SMT-20350
9	C759	CAPACITOR, fixed, electro: 20 mfd, -10%, +50%, 350v	Illinois Condenser Corp., SMT-20350
10	C727	CAPACITOR, fixed, electro: 20 mfd, -10%, +50%, 350v	Illinois Condenser Corp., SMT-20350
11	R749	RESISTOR, fixed, composition: 27k, 5%, 1w	RC32GF273J
12	TB30	TERMINAL BOARD, Tel-A-Scan:	Radiation, C9037-740
13	R781	RESISTOR, fixed, composition: 1m, 5%, 1/2w	RC20GF105J
14	R780	RESISTOR, fixed, composition: 470k, 5%, 1/2w	RC20GF474J
15	C769	CAPACITOR, fixed, ceramic: 0.05 mfd, -20%, +80%, 500v	Radio Materials Corp., B.05-3/4
16	C772	CAPACITOR, fixed, paper: 0.1 mfd, ±20%, 1000v	Cornell-Dubilier, PJ-10-P1
17	C768	CAPACITOR, fixed, paper: 0.5 mfd, 20%, 200v	Cornell-Dubilier, MTM-2-P5
18	R830	RESISTOR, fixed, composition: 100k, 5%, 1/2w	RC20GF104J
19	C771	CAPACITOR, fixed, ceramic: 0.05 mfd, -20%, +80%, 500v	Radio Materials Corp., B.05-3/4
20	R743	RESISTOR, fixed, composition: 100k, 5%, 1/2w	RC20GF104J
21	R778	RESISTOR, fixed, composition: 180k, 5%, 1/2w	RC20GF184J
22	C738	CAPACITOR, fixed, paper: 0.1 mfd, 20%, 200v	Cornell-Dubilier, CUB-2-P1

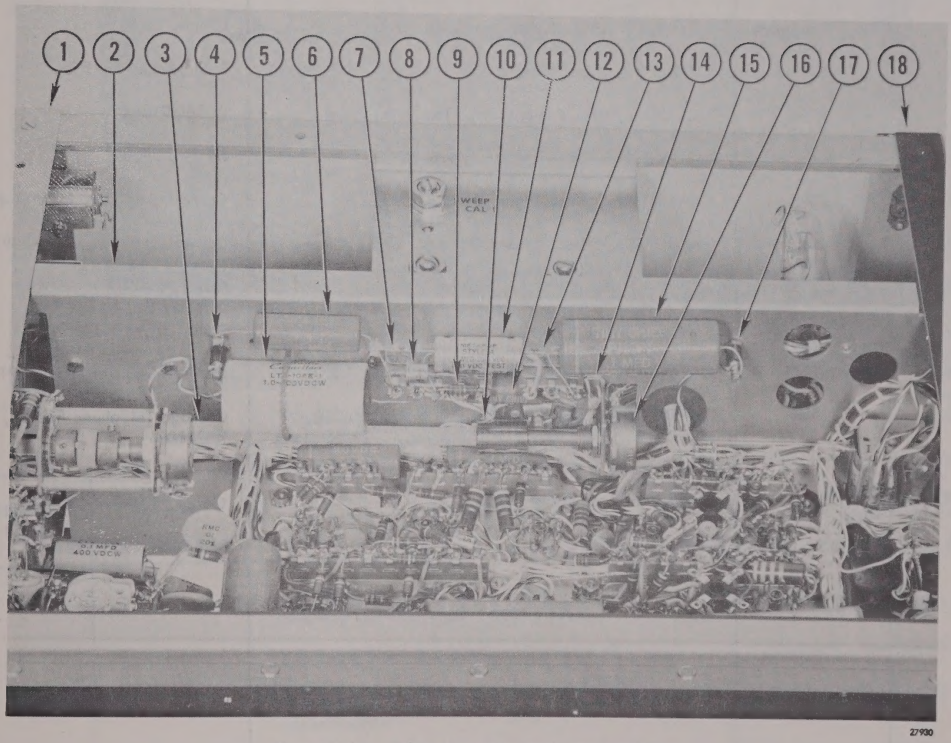


Figure 2-60. Tel-A-Scan Top Deck, Bottom View

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1		LIP, panel, front:	Radiation, 9037-322-3
2		DECK, top, Tel-A-Scan:	Radiation, D9037-761
3		SHAFT, extension:	Radiation, 9037-762
4	TP23 (tie point)	STANDOFF, terminal:	Garde, B3449-7HTC
5	C733	CAPACITOR, fixed, mylar: 1.0 mfd, 1%, 400v	Plastic Capacitor, LT4-105E
6	C740	CAPACITOR, fixed, paper: 0.1 mfd, 20%, 400v	Cornell-Dubilier, CUB-4-P1
7	TP24 (tie point)	TERMINAL STRIP: XXXP, phenolic	Cinch, 2005
8	CR703	DIODE:	Radio Receptor, PT5
9	R775	RESISTOR, fixed, composition: 18m, 5%, 1/2w	RC20GF186J
10		COUPLING, shaft: 1/4" to 1/4"	Miller, 39003
11	C741	CAPACITOR, fixed, paper: 0.5 mfd, 20%,	Cornell-Dubilier, MTM-2-P5
12	C735	CAPACITOR, fixed, paper: 0.1 mfd, 20%, 200v	Cornell-Dubilier, CUB-2-P1
13	TP25 (tie point)	TERMINAL STRIP: XXXP, phenolic	Cinch, 2003
14		BRACKET, vertical position:	Radiation, A9037-715
15	C762	CAPACITOR, fixed, paper: 0.1 mfd, 20%, 1000v	Cornell-Dubilier, PJ-10-P1
16	R726	RESISTOR, variable, composition: type RV2, 10k, +10%, 1w, linear taper, 3/8" bushing, 1-19/16" long shaft	Chicago Telephone Supply, KB22189
17		STANDOFF, terminal:	Garde, B3449-4HTC
18		COVER, rear:	Radiation, 9037-727-1

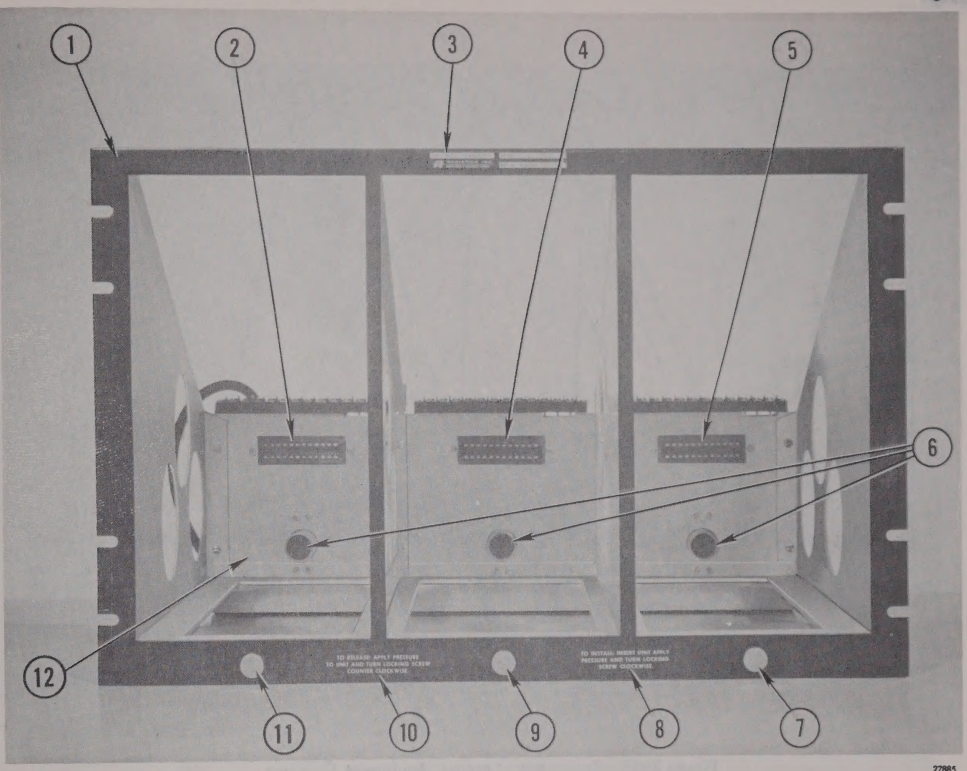


Figure 2-61. Rack-Mount Power Supply, Front View

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1		RACK-MOUNT FRAME: power supply	Radiation, D9037-441-2
2	J12	CONNECTOR, receptacle, electrical: 24-contact	Amphenol, 26-4200-24S
3		NAMEPLATE: serial number and model number identification	Radiation, B9037-714-14
4	J11	CONNECTOR: receptacle, electrical: 24-contact	Amphenol, 26-4200-24S
5	J10	CONNECTOR: receptacle, electrical: 24-contact	Amphenol, 26-4200-24S
6		GROMMET: ejection spring (3)	AN931-3-9
7		LATCH:	See Figure 2
8		PLATE, instruction: unit releasing instructions	Radiation, A9037-487
9		LATCH:	See Figure 2
10		PLATE, instruction: unit installation instructions	Radiation, A9037-486
11		LATCH:	See Figure 2

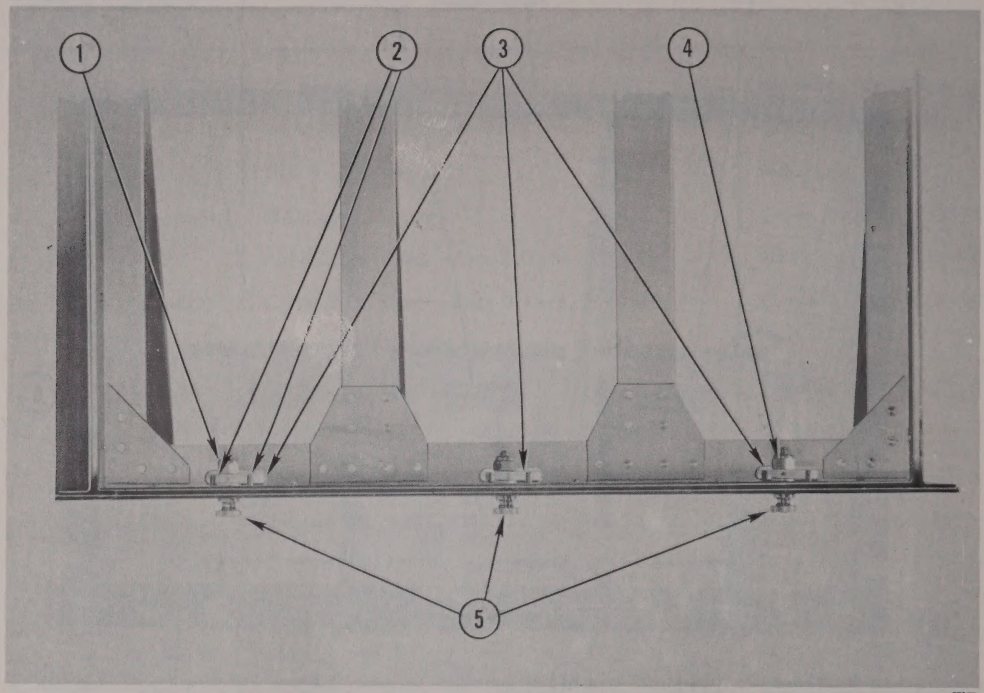


Figure 2-62. Rack-Mount Latches, Equipment Mounting

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1		SCREW, set: (3), allen head, 6-32, 1/8 in. lg.	AN565DC632H2
2		ROLL PIN: (6)	Radiation, 79-028-125-0375
3		CAM, locking: (3)	Radiation, A9037-447
4		NUT, lock: (3)	ESNA, 79NE040
5		THUMBSCREW, knurled:	Radiation, A9037-478

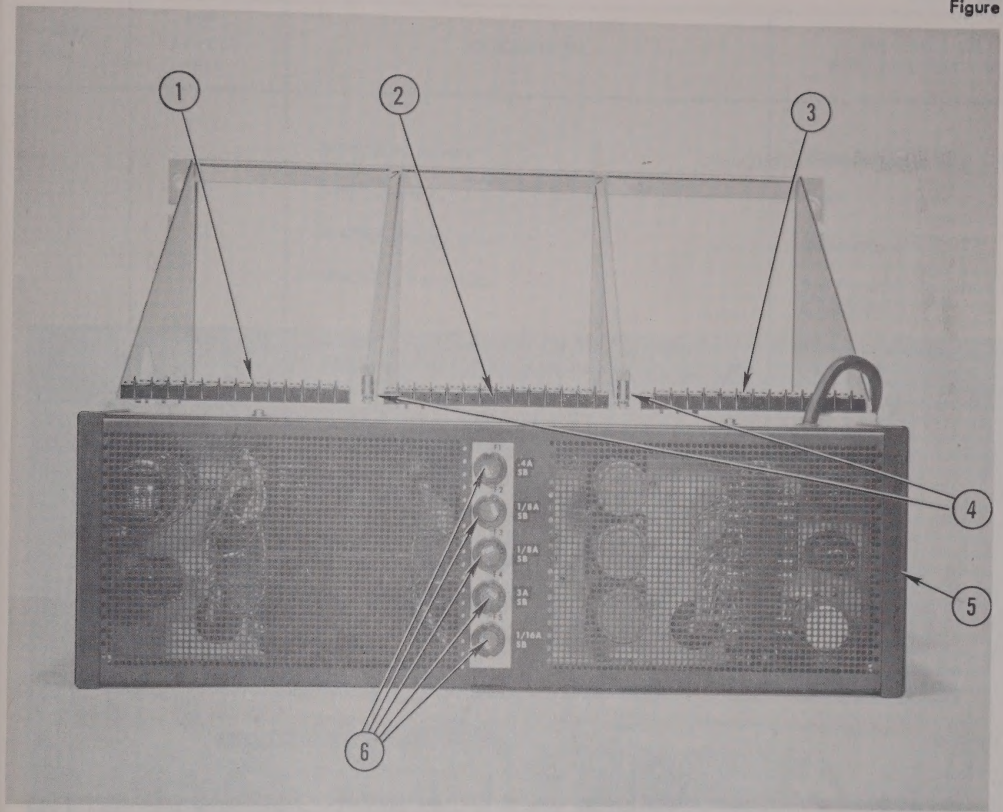


Figure 2-63. Rack-Mount Power Supply, Rear View

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1	TB10	TERMINAL STRIP: molded barrier type, 12 terminal, w/backing strip	General Products, 440Y-12
2	TB11	TERMINAL STRIP: molded barrier type, 12 terminal, w/backing strip	General Products, 440Y-12
3	TB12	TERMINAL STRIP: molded barrier type, 12 terminal, w/backing strip	General Products, 440Y-12
4		TERMINAL, post: (2)	Jas. Millen Mfg., 37222
5		COVER: power supply	Radiation, D9037-482-2
6		FUSEHOLDERS:	See Figure 5

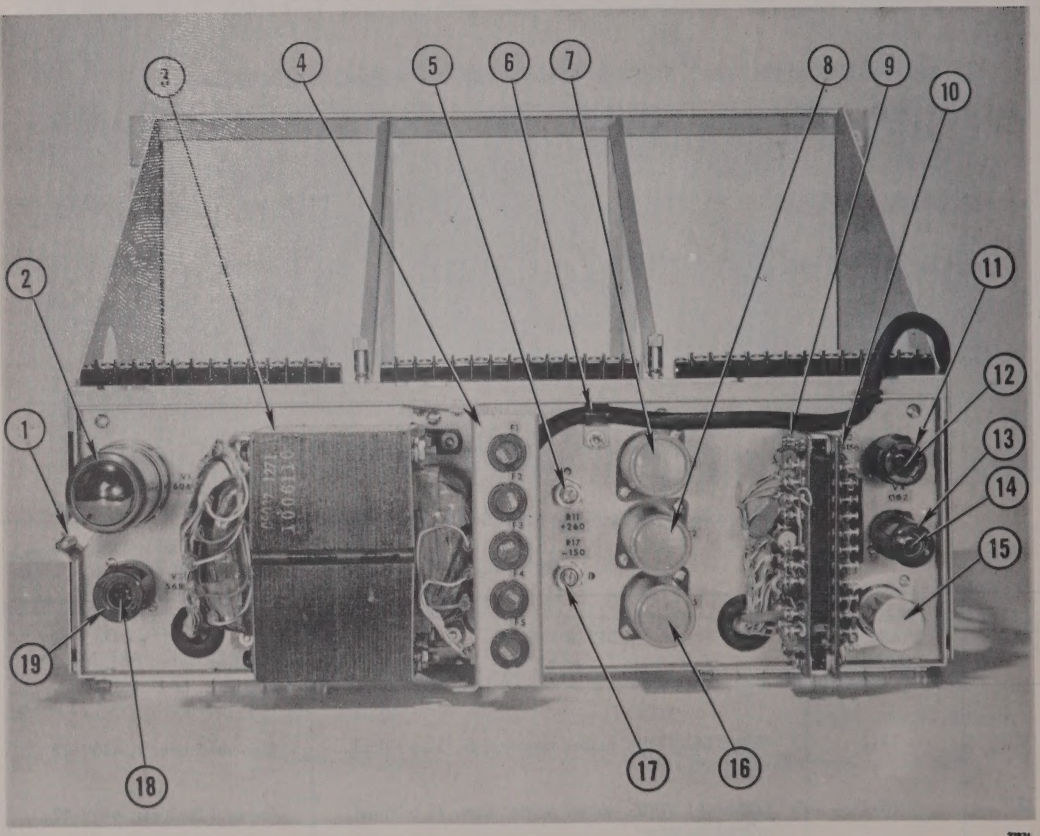


Figure 2-64. Rack-Mount Chassis, Component Mounting

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1		RETAINER, tophat:	Times Facsimile Corp., 42/3T
2	V1	TUBE, electron:	6080
3	T1	TRANSFORMER, power:	Radiation, C9037-1271
4		BRACKET, fuseholder:	See Figure 5, Radiation C9037-495-1
5	R11	RESISTOR, variable, composition: 25k, ±10%, linear taper, 0.5 in. lg. slotted shaft, locking type w/locknut	Chicago Telephone Supply, JW2942
6		CLAMP, cable:	See Figure 5
7	C1	CAPACITOR, fixed, electrolytic: 40 mfd. 40 vdc, w/phenolic mounting wafers and insulating sleeve CE7.	Mallory, FP146
8	C2	CAPACITOR, fixed, electrolytic: 40 mfd. 40 vdc, w/phenolic mounting wafers and insulating sleeve CE7.	Mallory, FP146
9	TB5	TERMINAL BOARD:	See Figure 8, Radiation B9037-1272
10	TB6	TERMINAL BOARD:	See Figure 9, Radiation B9037-1273
11		TUBE SHIELD:	TS-102-U02
12	V2	TUBE, electron:	6AU6
13		TUBE SHIELD:	Cinch, TS-102-U03
14	V4	TUBE, electron:	OB2
15	C3	CAPACITOR, fixed, electrolytic: 40 mfd., 450 vdc, w/metal mounting flange MP4	Mallory, FP146
16	C5	CAPACITOR, fixed, electrolytic: 40 mfd., 450 vdc, w/phenolic mounting wafers and insulating sleeve, CE7.	Mallory, FP146
17	R17	RESISTOR, variable: 2K, ±10%, 1/2w, 0.5 in. lg. slotted shaft, locking type w/locknut	Chicago Telephone Supply, KF5630
18		TUBE SHIELD:	Cinch, TS-103-U02
19	V3	TUBE, electron:	5687

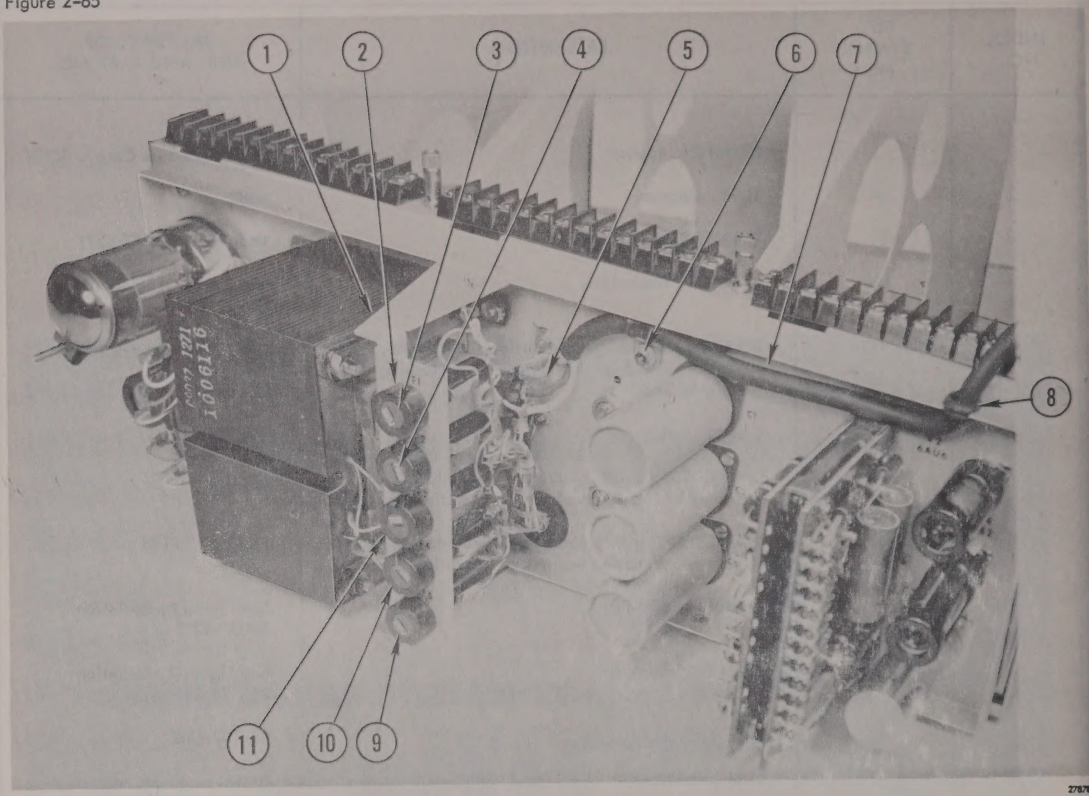


Figure 2-65. Rack-Mount Fuseholder Bracket and Line Cord Terminal Strip

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1		BRACKET: fuseholder	Radiation, C9037-495-1
2		FUSEHOLDER: (5)	Littelfuse, 341001
3	F1	FUSE, cartridge: 4/10 amp, Slo-blo	Littelfuse, 313.400
4	F2	FUSE, cartridge: 1/8 amp, Slo-blo	Littelfuse, 313.125
5	TB3	TERMINAL STRIP: XXXP, phenolic	Cinch, 2003
6		CLAMP, cable:	Holub, EC5
7		LINE CORD:	Belden, I 7408-S
8		GROMMET, rubber:	General Cement, GCH036F
9	F5	FUSE, cartridge: 1/16 amp, Slo-blo	Littelfuse, 313.062
10	F4	FUSE, cartridge: 3 amp, Slo-blo	Littelfuse, 313003
11	F3	FUSE, cartridge: 1/8 amp, Slo-blo	Littelfuse, 313.125

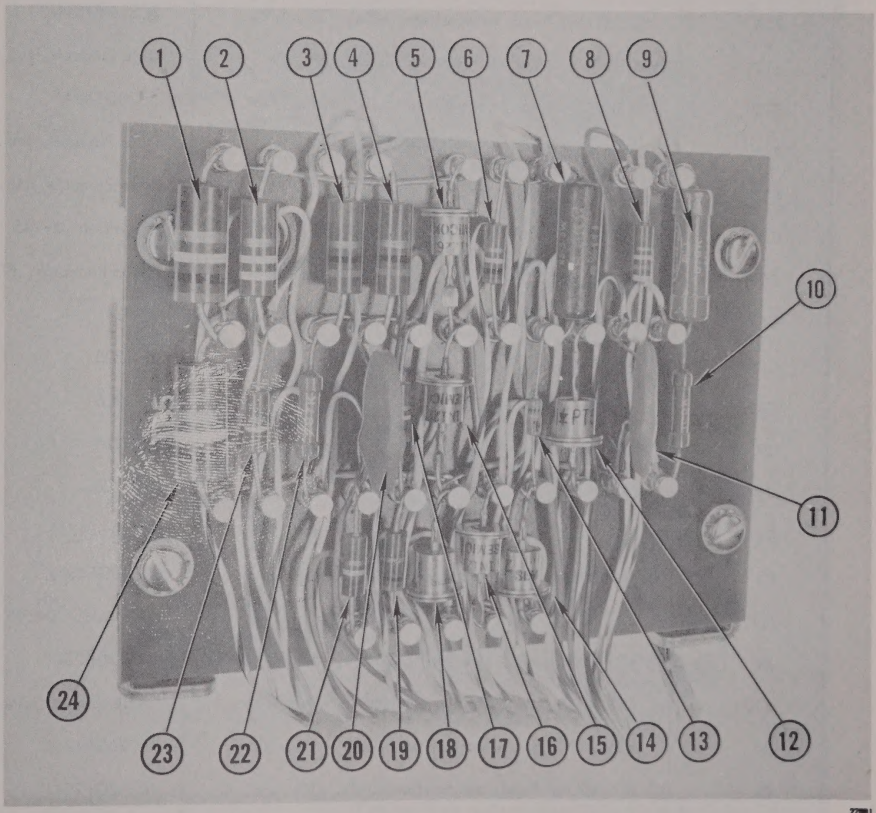


Figure 2-66. Rack-Mount Terminal Board, TB5

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1	R1	RESISTOR, fixed, composition: 100k ±5%, 2w	RC42GF104J
2	R3	RESISTOR, fixed, composition: 240k ±5%, 1w	RC32GF244J
3	R6	RESISTOR, fixed, composition: 51 ohms, ±5%, 1w	RC32GF510J
4	R7	RESISTOR, fixed, composition: 51 ohms, ±5%, 1w	RC32GF510J
5	CR3	DIODE:	IN1226
6	R14	RESISTOR, fixed, composition: 100k, ±5%, 1/2w	RC20GF104J
7	R13	RESISTOR, fixed, wirewound: 38.3k, ±5%, 5w	Dale Products, Inc. RS-5
8	R15	RESISTOR, fixed, composition: 470k, ±5%, 1/2w	RC20GF474J
9	R16	RESISTOR, fixed, carbon film: 5.6k, ±1%, 1w	Dale Products, Inc. DCS-1
10	R12	RESISTOR, fixed, carbon film: 100k, ±1%, 1w	Dale Products, Inc. DCS-1/2
11	C6	CAPACITOR, fixed, ceramic disc: 0.05 mfd. 500 vdc	Centralab D-.05
12	CR1	DIODE:	Radio Receptor PT-5
13	CR7	DIODE: voltage reference, 10v, ±10%	IN714
14	CR6	DIODE:	IN1226
15	CR5	DIODE:	IN1226
16	CR2	DIODE:	IN1226
17	CR4	DIODE:	IN1226
18	R8	RESISTOR, fixed, composition: 120k, ±5%, 1/2w	RC20GF124J
19	R5	RESISTOR, fixed, composition: 1k, ±5%, 1/2w	RC20GF102J
20	C4	CAPACITOR, fixed, ceramic disc: 0.05 mfd. 500 vdcw	Centralab, D-.05
21	R9	RESISTOR, fixed, composition: 220k, ±5%, 1/2w	RC20GF224J
22	R10	RESISTOR, fixed, carbon film: 287k, ±1%, 1/2w	Dale Products, Inc., DCS-1/2
23	R4	RESISTOR, fixed, composition: 120k, ±5%, 1/2w	RC20GF124J
24	R2	RESISTOR, fixed, composition: 100k, ±5%, 2w	RC42GF104J

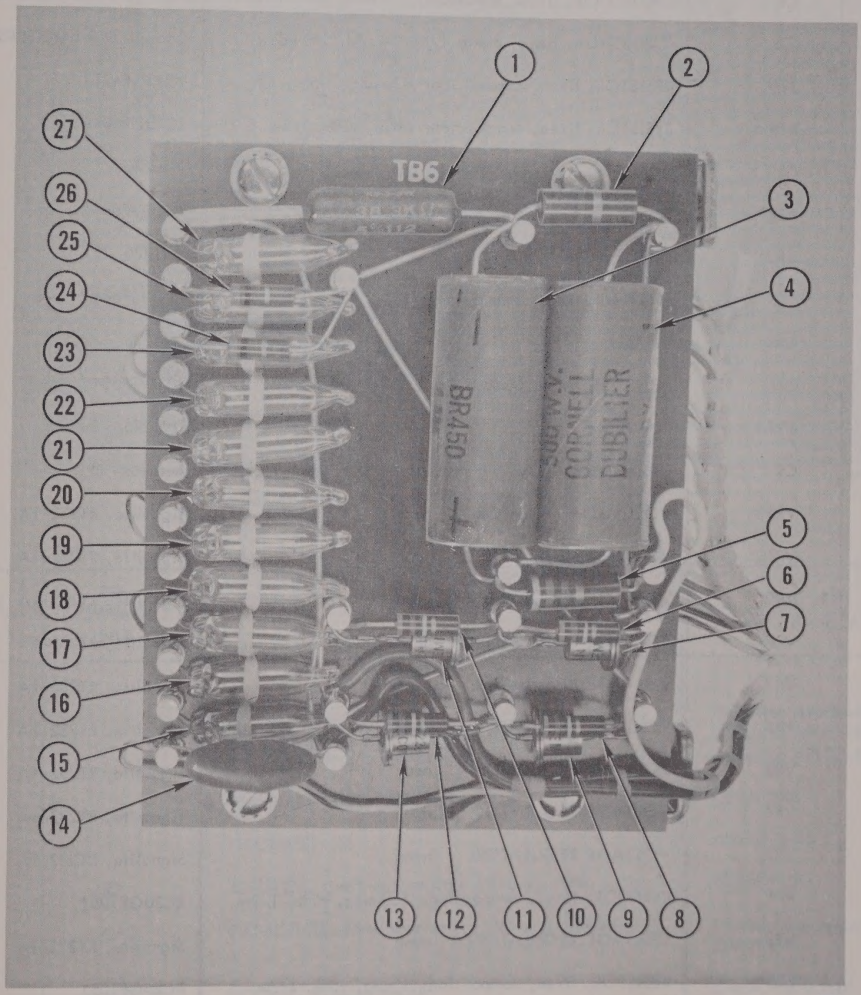


Figure 2-67. Rack-Mount Terminal Board, TB6

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1	R26	RESISTOR, fixed, wire wound: 38.3k, ±5%, 5w	Dale Products Inc., RS-5
2	R23	RESISTOR, fixed, composition: 2.2 meg, ±5%, 1w	RC32GF225J
3	C8	CAPACITOR, fixed, electrolytic: 4 mfd, 500 vdcw	Cornell-Dubilier, BR450
4	C7	CAPACITOR, fixed, electrolytic: 4 mfd, 500 vdcw	Cornell-Dubilier, BR450
5	R20	RESISTOR, fixed, composition: 470 ohm, ±5%, 1w	RC32GF471J
6	R19	RESISTOR, fixed, composition: 680k, ±5%, 1/2w	RC20GF684J
7	CR9	DIODE:	1N1226
8	R22	RESISTOR, fixed, composition: 680k, ±5%, 1/2w	RC20GF684J
9	CR11	DIODE:	1N1226
10	R18	RESISTOR, fixed, composition: 680k, ±5%, 1/2w	RC20GF684J
11	CR8	DIODE:	1N1226
12	R21	RESISTOR, fixed, composition: 680k, ±5%, 1/2w	RC20GF684J
13	CR10	DIODE:	1N1226
14	C9	CAPACITOR, fixed, ceramic disc : 0.03 mfd, 1 kv	Aerovox, BPD
15	VR11	VOLTAGE REGULATOR: neon	Signalite, RT232-1A
16	VR10	VOLTAGE REGULATOR: neon	Signalite, RT232-1A
17	VR9	VOLTAGE REGULATOR: neon	Signalite, RT232-1A
18	VR8	VOLTAGE REGULATOR: neon	Signalite, RT232-1A
19	VR7	VOLTAGE REGULATOR: neon	Signalite, RT232-1A
20	VR6	VOLTAGE REGULATOR: neon	Signalite, RT232-1A
21	VR5	VOLTAGE REGULATOR: neon	Signalite, RT232-1A
22	VR4	VOLTAGE REGULATOR: neon	Signalite, RT232-1A
23	VR3	VOLTAGE REGULATOR: neon	Signalite, RT232-1A
24	R24	RESISTOR, fixed, composition: 1.0 meg, ±5%, 1/2w	RC20GF105J
25	VR2	VOLTAGE REGULATOR: neon	Signalite, RT232-1A
26	R25	RESISTOR, fixed, composition: 1 meg, ±5%, 1/2w	RC20GF105J
27	VR1	VOLTAGE REGULATOR: neon	Signalite, RT232-1A

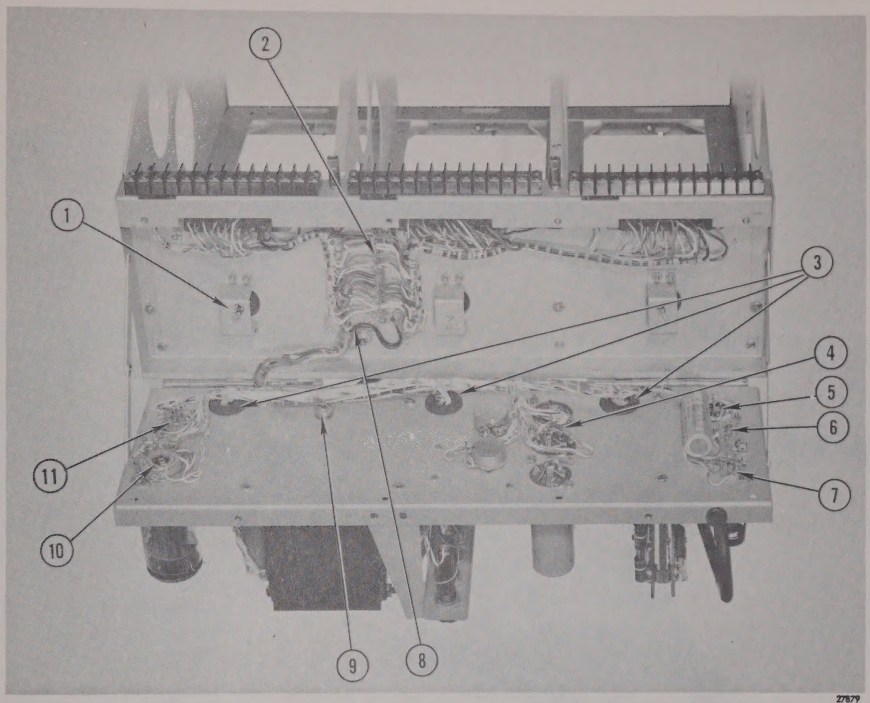


Figure 2-68. Rack-Mount Back Plate, Rear View

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1		BRACKET: ejection spring (3) SPRING, ejection: (3) (not shown) SHIELD, spring: (3) (not shown)	Radiation A9037-430 Radiation A9037-432 Radiation A9037-427
2		TERMINAL STRIP: XXXP, phenolic	Cinch 2009
3		GROMMET: (3)	AN931-8-13
4	R2	RESISTOR, fixed, composition: 150 ohm, ±5%, 1/2w	RC20GF151J
5	C10	CAPACITOR, fixed electrolytic: 20 mfd. 350 vdcw	Illinois Condenser Company SMT20350
6	XV4	SOCKET, tube: seven pin	Cinch, TS102P01
7	XV2	SOCKET, tube: seven pin	Cinch, TS102P01
8		CLAMP, cable:	Holub EC6
9		CLAMP, cable:	Holub EC7
10	XV1	SOCKET, tube: eight pin	Cinch, TS101P01
11	XV3	SOCKET, tube: nine pin	Cinch, TS103P01

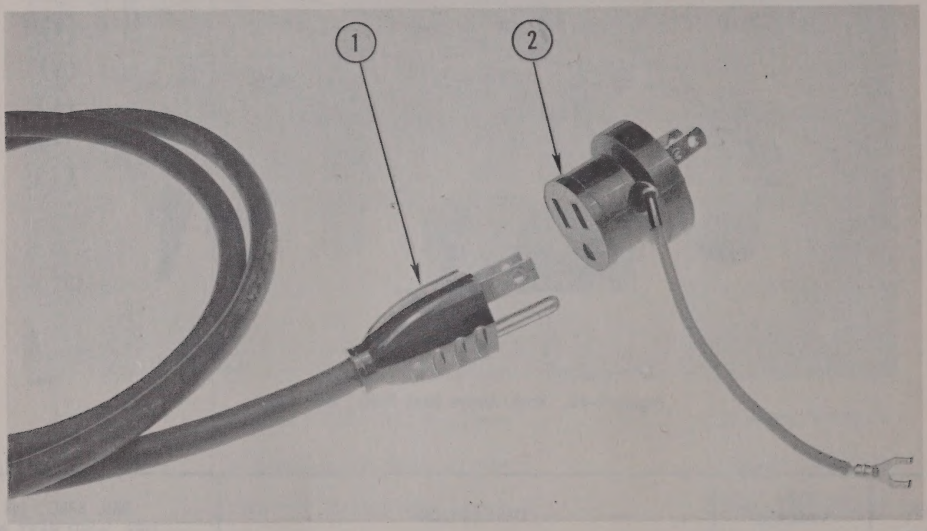


Figure 2-69. Rack-Mount Power Plug Adapter

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1		LINE CORD:	See Figure 2-65
2		ADAPTER: power plug	Radiation, A9037-470

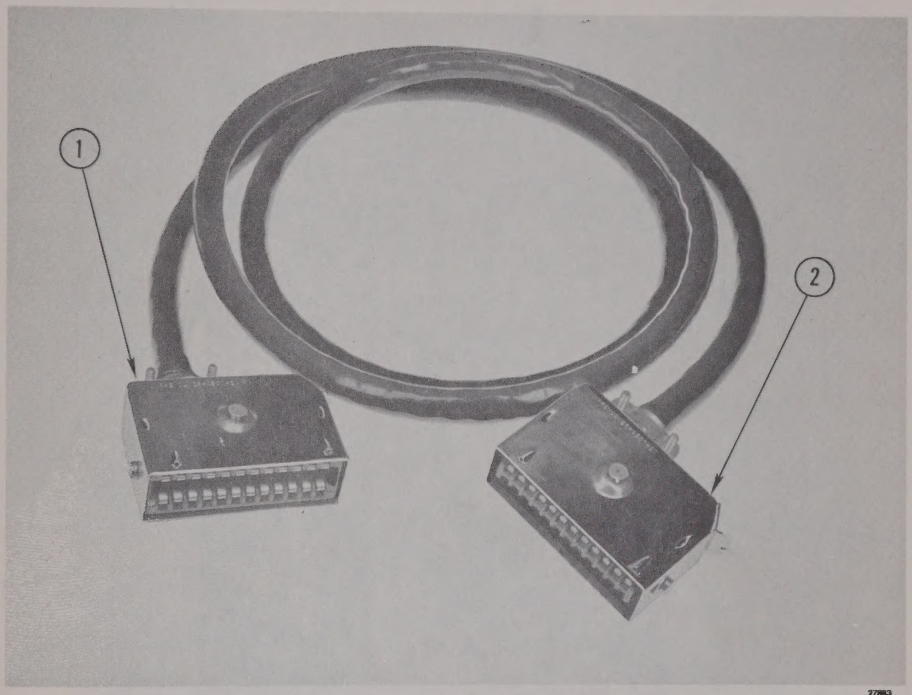


Figure 2-70. Rack-Mount Test Cable, 14-107A

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1	J9	CONNECTOR, receptacle: 24 contact	Amphenol, 26-4301-24S
2	P9	CONNECTOR, plug: 24 contact	Radiation, A9037-464B

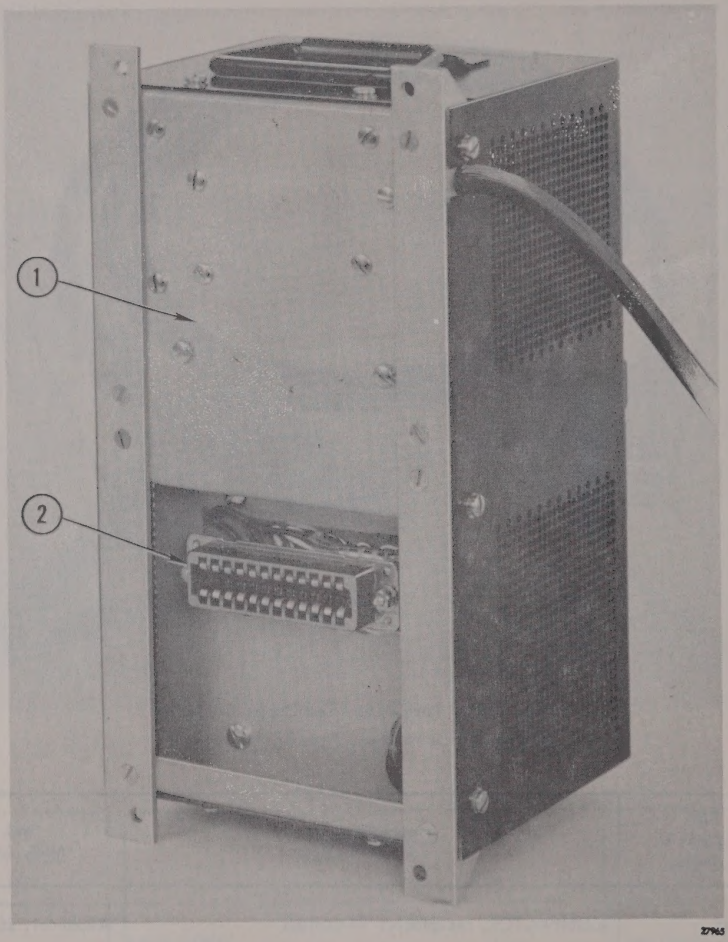


Figure 2-71. Portable Power Supply, Front View.

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1		CHASSIS:	Radiation, D9037-502-1
2	J1	CONNECTOR, receptacle: 24 contact	Amphenol, 26-4200-24S

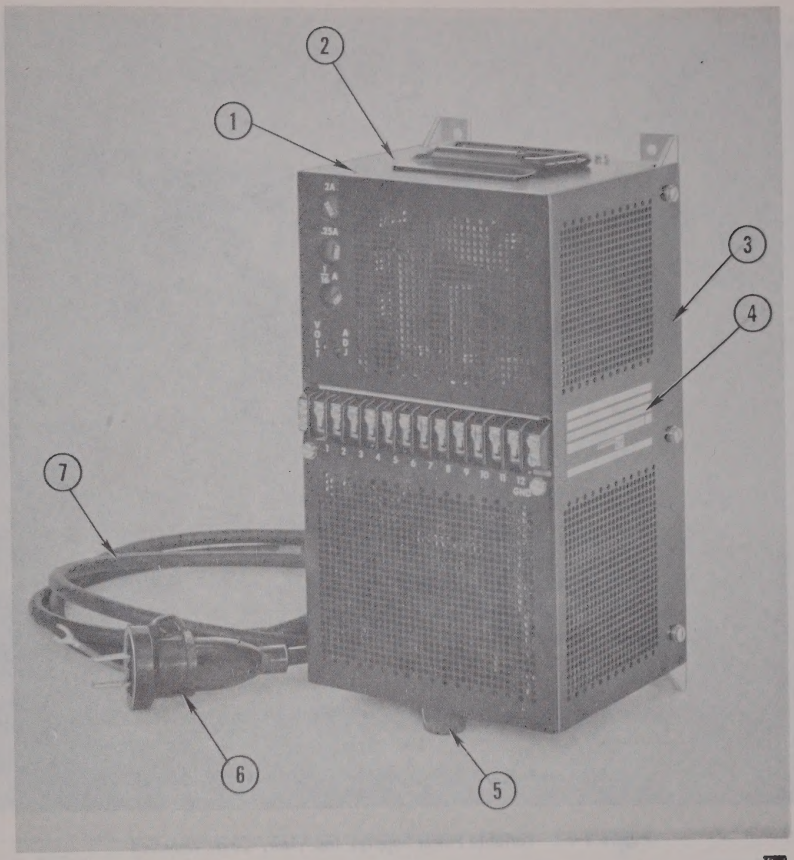


Figure 2-72. Portable Power Supply, Rear View

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1		NAMEPLATE: serial number and model number identification	Radiation, B9037-714-21
2		COVER, top:	Radiation, C9037-511-1
3		COVER, rear:	Radiation, B9037-1501-1
4		NAMEPLATE: serial number and model number identification. Also shows USAF stock number and contract number.	Radiation, C9037-797-26
5		BUMPER, recessed: rubber	India Rubber, K954022
6		ADAPTER, power plug:	Radiation, C9037-470
7		LINE CORD:	Belden, 17408-2

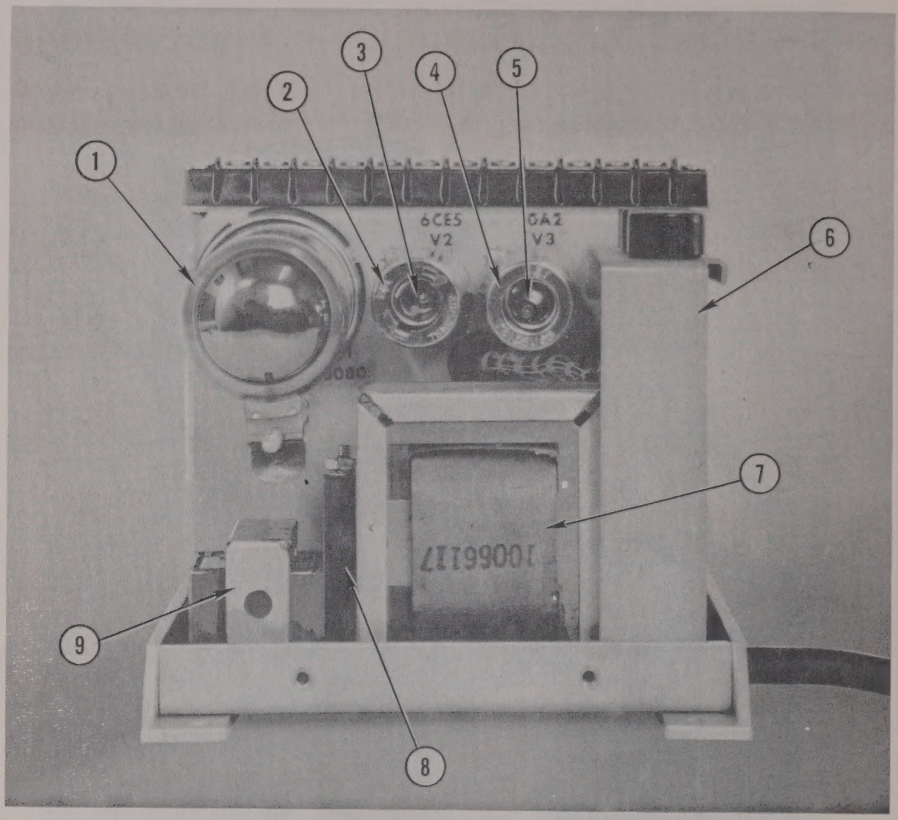


Figure 2-73. Portable Power Supply, Top View, Cover Removed

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1		HAT, retainer:	Times Facsimile, 3T
2		TUBE SHIELD:	Eby, TS-102-U02
3	V2	TUBE, electron:	General Electric, 6CE5
4		TUBE SHIELD:	Eby, TS-102-U03
5	V3	TUBE, electron:	CBS, OB2
6		BRACKET, fuseholder:	Radiation, C9037-506-1 See Figure 2-74
7	L1	FILTER, choke: 7 hy, 150 ma	Radiation, B9037-519-1
8	R19	RESISTOR, fixed, wire wound: 4.5k, ±5%, 10w	Clarostat, AC-10F
9	L2	FILTER, choke: 5 hy, 50 ma	Radiation, B9037-518-1

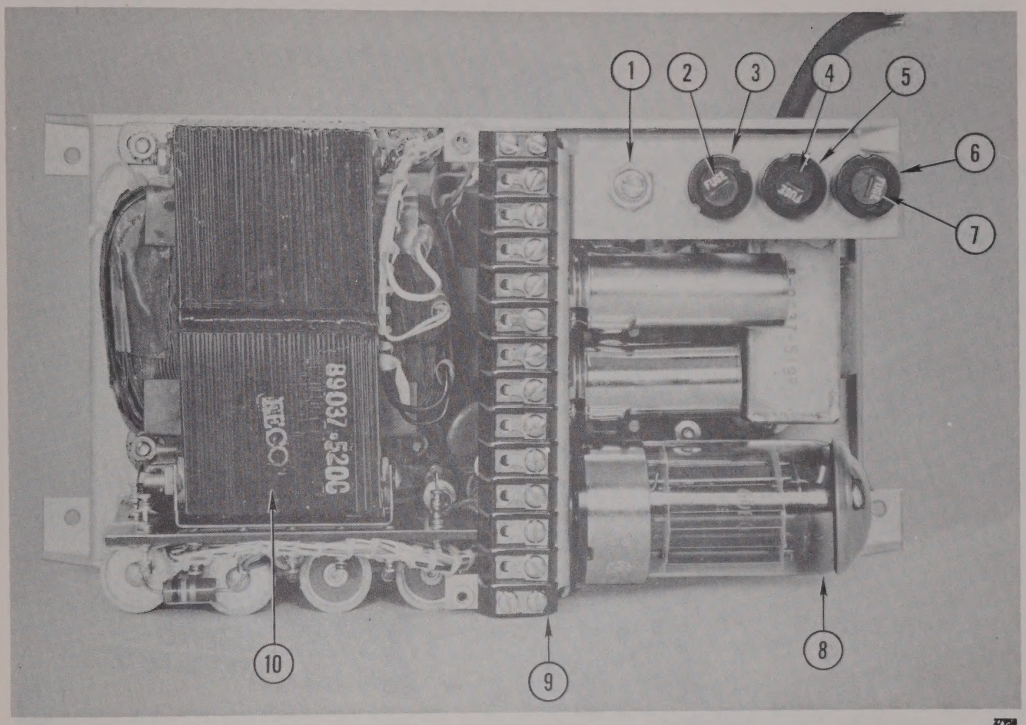


Figure 2-74. Portable Power Supply, Rear View, Cover Removed

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1	R8	RESISTOR, variable: 100k, ±10%, slotted shaft	Chicago Telephone Supply, FR6643
2	F3	FUSE, cartridge: 0.625 amp, 3AG, slo-blo type	Littelfuse, 313.062
3	XF3	FUSEHOLDER, cartridge:	Littelfuse, 341001
4	F2	FUSE, cartridge: 0.25 amp, 3AG, slo-blo type	Littelfuse, 313.250
5	XF2	FUSEHOLDER, cartridge:	Littelfuse, 341001
6	XF1	FUSEHOLDER, cartridge:	Littelfuse, 341001
7	F1	FUSE, cartridge: 2 amp, 3AG, slo-blo type	Littelfuse, 313.002
8	V1	TUBE, electron:	General Electric, 6080
9	TB1	TERMINAL STRIP: barrier type	Kulka, 600A-Y-12
10	T1	TRANSFORMER, power:	Radiation, B9037-520-1

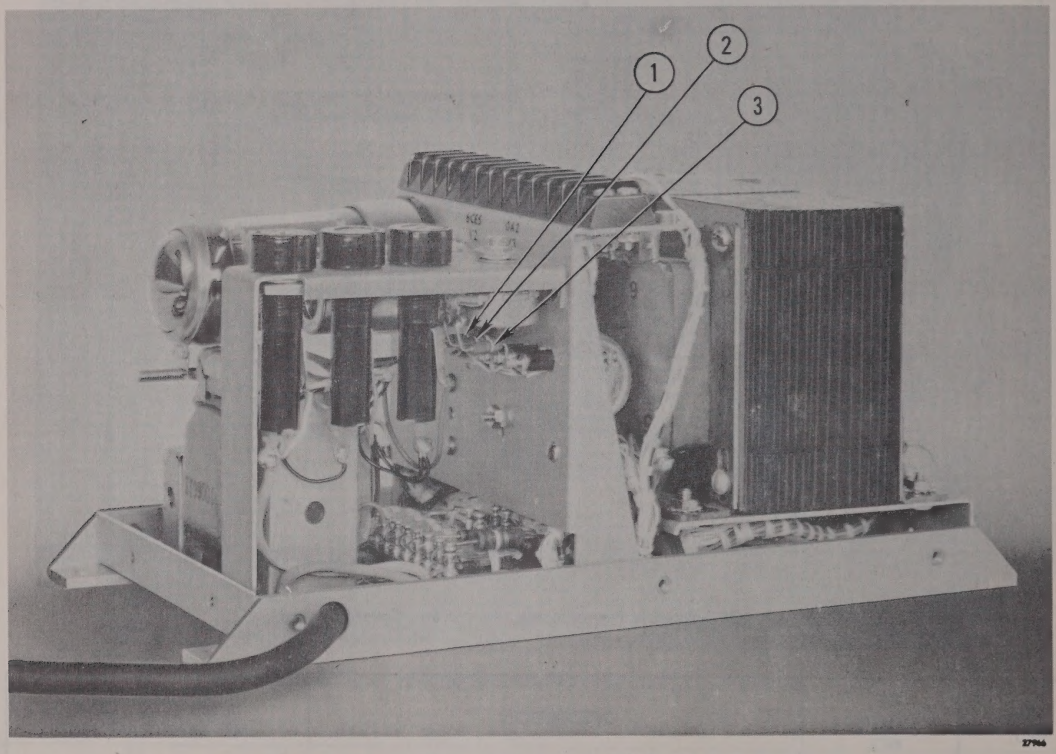


Figure 2-75. Portable Power Supply, Right Side, Cover Removed

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1	R4	RESISTOR, fixed, composition: 560k, ±5%, 1/2w	RC20GF564J
2	R7	RESISTOR, fixed, composition: 470k, ±5%, 1/2w	RC20GF474J
3	R9	RESISTOR, fixed, composition: 270k, ±5%, 1/2w	RC20GF274J

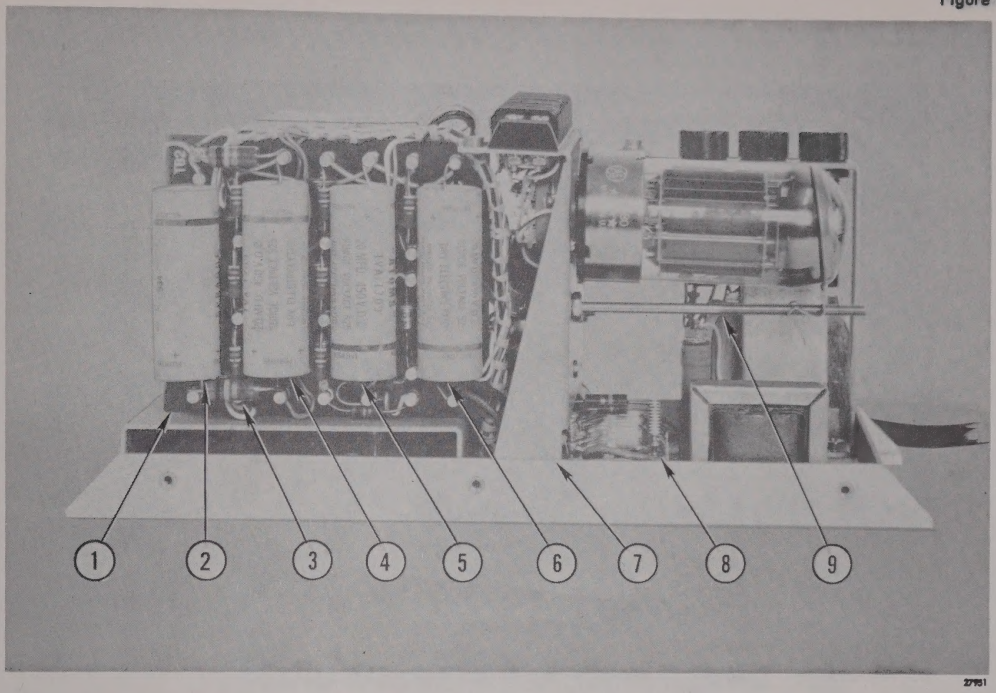


Figure 2-76. Portable Power Supply, Left Side, Cover Removed

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1	TB2	TERMINAL BOARD:	Radiation, D9037-541-2 See Figures 2-79 and 2-80
2	C11	CAPACITOR, fixed, electrolytic: 20 mfd, -10%, +50%, 450 vdcw	Sprague, TVA-1709
3	R2	RESISTOR, fixed, composition: 100k, ±5%, 1/2w	RC20GF104J
4	C3	CAPACITOR, fixed, electrolytic: 20 mfd, -10%, +50%, 450 vdcw	Sprague, TVA-1709
5	C8	CAPACITOR, fixed, electrolytic: 20 mfd, -10%, +50%, 450 vdcw	Sprague, TVA-1709
6	C9	CAPACITOR, fixed, electrolytic: 20 mfd, -10%, ±50%, 450 vdcw	Sprague, TVA-1709
7		BRACKET, tube mounting:	Radiation, B9037-547-1 See Figure 2-78
8	TB3	TERMINAL BOARD:	Radiation, B9037-548-1 See Figure 2-77
9		POST, retainer:	Times Facsimile, 42

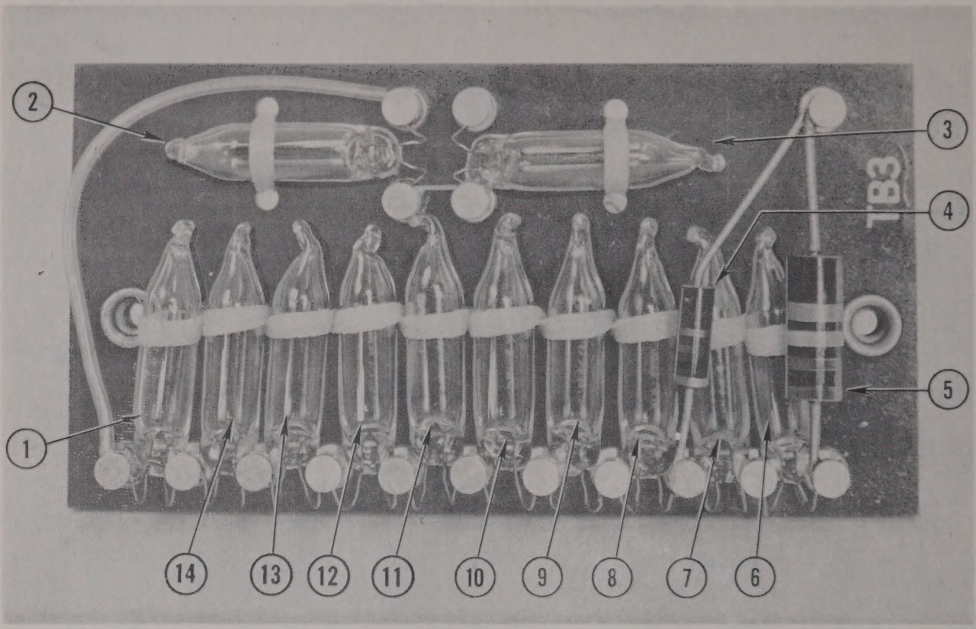


Figure 2-77. Portable Power Supply, Terminal Board TB3

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1	VR10	VOLTAGE REGULATOR: neon	Signalite, RT232-1A
2	VR11	VOLTAGE REGULATOR: neon	Signalite, RT232-1A
3	VR12	VOLTAGE REGULATOR: neon	Signalite, RT232-1A
4	R12	RESISTOR, fixed, composition: 1.0 meg, ±5%, 1/2w	RC20GF105J
5	R11	RESISTOR, fixed, composition: 120k, ±5%, 1w	RC32GF124J
6	VR1	VOLTAGE REGULATOR: neon	Signalite, RT232-1A
7	VR2	VOLTAGE REGULATOR: neon	Signalite, RT232-1A
8	VR3	VOLTAGE REGULATOR: neon	Signalite, RT232-1A
9	VR4	VOLTAGE REGULATOR: neon	Signalite, RT232-1A
10	VR5	VOLTAGE REGULATOR: neon	Signalite, RT232-1A
11	VR6	VOLTAGE REGULATOR: neon	Signalite, RT232-1A
12	VR7	VOLTAGE REGULATOR: neon	Signalite, RT232-1A
13	VR8	VOLTAGE REGULATOR: neon	Signalite, RT232-1A
14	VR9	VOLTAGE REGULATOR: neon	Signalite, RT232-1A

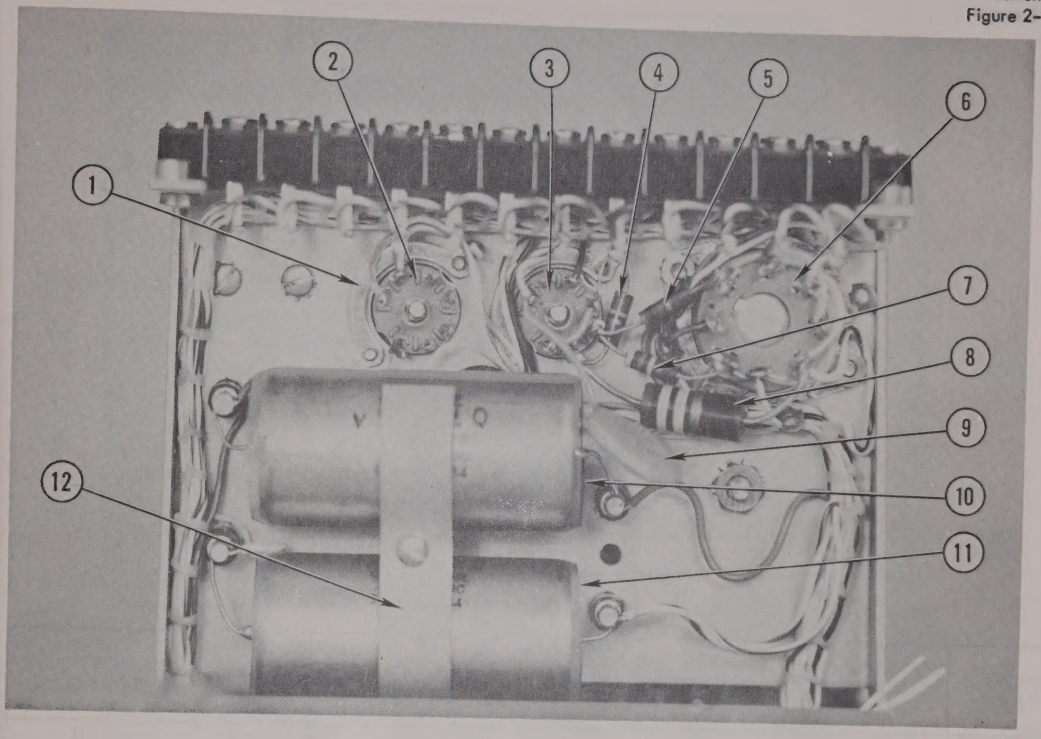


Figure 2-78. Portable Power Supply, Tube Mounting Bracket, Bottom View

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1		NUT, strap: (2)	Cinch, 402
2	XV3	SOCKET, tube: 7-pin, miniature	Cinch, TS102P01
3	XV2	SOCKET, tube: 7-pin, miniature	Cinch, TS102P01
4	R6	RESISTOR, fixed, composition: 22k, ±5%, 1/2w	RC20GF223J
5	R21	RESISTOR, fixed, composition: 1k, ±5%, 1/2w	RC20GF102J
6	XV1	SOCKET, tube: octal	Cinch, 8AM
7	R3	RESISTOR, fixed, composition: 470k, ±5%, 1/2w	RC20GF474J
8	R5	RESISTOR, fixed, composition: 240k, ±5%, 2w	RC42GF244J
9	C4	CAPACITOR, fixed: 0.05 mfd, -20%, +80%, 500 vdcw	Radio Materials Corp., B.05-3/4
10	C5	CAPACITOR, fixed: 0.47 mfd, ±20%, 1000 vdcw	Sprague, 91P474010-S4
11	C6	CAPACITOR, fixed: 0.47 mfd, ±20%, 1000 vdcw	Sprague, 91P474010-S4
12		BRACKET, capacitor:	Radiation, A9037-545-1

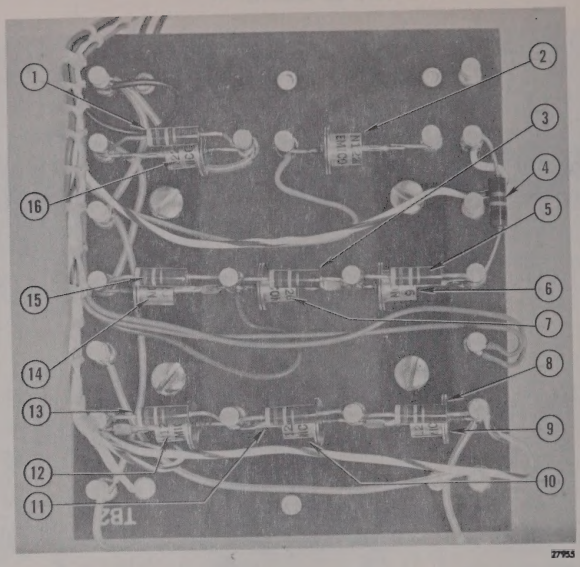


Figure 2-79. Portable Power Supply, Terminal Board TB2, Front View

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1	R32	RESISTOR, fixed, composition: 470k, ±5%, 1/2w	RC20GF474J
2	CR9	DIODE:	1N1226
3	R29	RESISTOR, fixed, composition: 470k, ±5%, 1/2w	RC20GF474J
4	R10	RESISTOR, fixed, composition: 470k, ±5%, 1/2w	RC20GF474J
5	R30	RESISTOR, fixed, composition: 470k, ±5%, 1/2w	RC20GF474J
6	CR6	DIODE:	1N1226
7	CR5	DIODE:	1N1226
8	R24	RESISTOR, fixed, composition: 470k, ±5%, 1/2w	RC20GF474J
9	CR10	DIODE:	1N1226
10	CR2	DIODE:	1N1226
11	R25	RESISTOR, fixed, composition: 470k, ±5%, 1/2w	RC20GF474J
12	CR1	DIODE:	1N1226
13	R23	RESISTOR, fixed, composition: 470k, ±5%, 1/2w	RC20GF474J
14	CR7	DIODE:	1N1226
15	R31	RESISTOR, fixed, composition: 470k, ±5%, 1/2w	RC20GF474J
16	CR8	DIODE:	1N1226

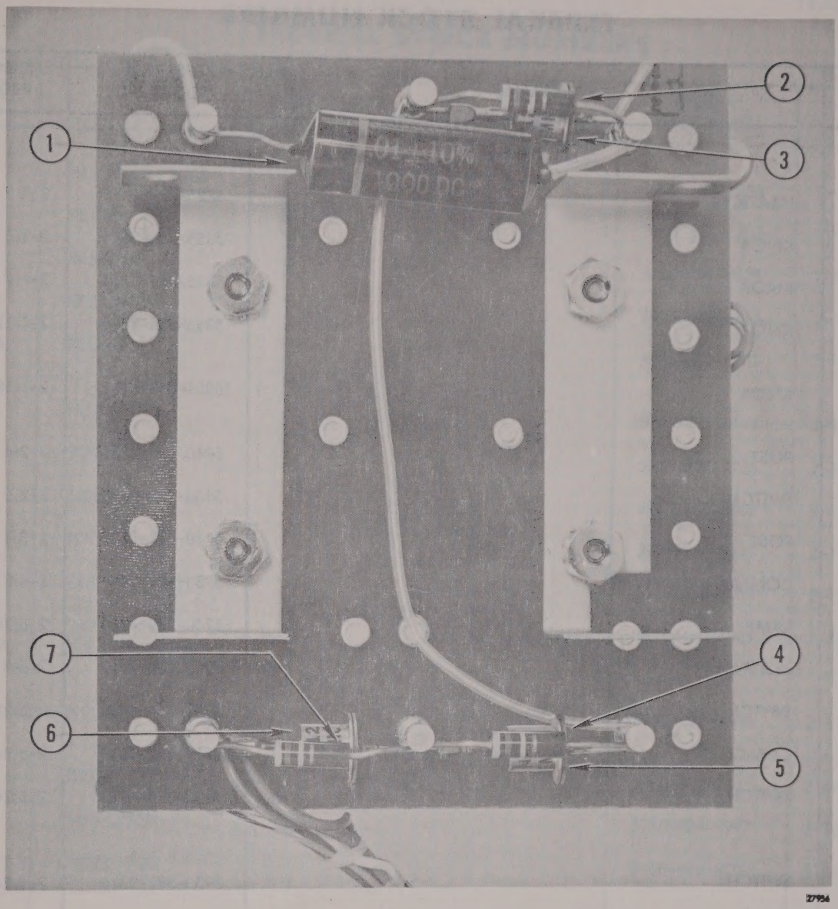


Figure 2-80. Portable Power Supply, Terminal Board TB2, Rear View

INDEX NO.	REF. SYMBOL NO.	DESCRIPTION	MIL SPEC. OR MFR. AND PART NO.
1	C1	CAPACITOR, fixed, paper: 0.01 mfd, ±10%, 1000 vdcw	Sprague, 10TM-S1
2	R28	RESISTOR, fixed, composition: 470k, ±5%, 1/2w	RC20GF474J
3	CR11	DIODE:	1N1226
4	R27	RESISTOR, fixed, composition: 470k, ±5%, 1/2w	RC20GF474J
5	CR4	DIODE:	1N1226
6	CR3	DIODE:	1N1226
7	R26	RESISTOR, fixed, composition: 470k, ±5%, 1/2w	RC20GF474J

FEDERAL STOCK NUMBERS

PART NO.	PART NAME	FEDERAL STOCK NO.	FIGURE AND INDEX NOS.
	TRANSMITTER		
	GRATICLE	6625-797-0196	2-1:2
(For S101)	KNOB	5355-284-5514	2-1:6
(For R129)	KNOB	5355-284-5514	2-1:7
(For S119, S118)	KNOB	5355-824-8986	2-1:12,13
(For S103, S102)	KNOB	5355-049-8572	2-1:18,19
	POST	5940-615-2282	2-2:4
S111	SWITCH	5930-754-8438	2-2:5
	POST	5940-688-2770	2-3:4
P101	CONNECTOR	5935-697-3479	2-4:2
I2	LAMP	6240-270-4286	2-5:2
R153	RESISTOR	5905-824-7911	2-5:8
S103	SWITCH	5930-754-8428	2-5:23
C101	CAPACITOR	5910-669-1510	2-5:24
S119,S118, S117,S116, S115	SWITCH	5930-825-7933	2-5:28 thru 32
S104	SWITCH	5930-587-9316	2-5:36
R129	RESISTOR	5905-822-5922	2-5:37
R290/S101	RESISTOR	5905-837-7943	2-5:38
I1	LAMP	6240-770-3372	2-5:40
R325,R323, R322,R324, R326	RESISTOR	5905-822-5917	2-8:12,14,16,19 21
V5,V3	ELECTRON TUBE	5960-553-3520	2-9:5,9
	SHIELD	5960-264-3004	2-9:5,6,9,11,12 18 thru 27,29
V4,V2,V1, V16,V8,V13, V7,V12,V6, V11,V15,V10	ELECTRON TUBE	5960-834-7504	2-9:6,11,12,19 thru 27 and 29
	CHOKE	5950-755-9053	2-9:15,16,17

FEDERAL STOCK NUMBERS

PART NO.	PART NAME	FEDERAL STOCK NO.	FIGURE AND INDEX NOS.
V9	ELECTRON TUBE	5960-193-5136	2-9:18
RL1	RELAY	5945-615-1302	2-9:28
R128	RESISTOR	5905-822-0676	2-10:2
R165	RESISTOR	5905-822-0675	2-10:3
R171,R136, R285	RESISTOR	5905-822-5902	2-10: 7,10,12
	RELAY	5945-825-0144	2-11:2
	SOCKET	5935-502-7735	2-11:8
	ELECTRON TUBE	5960-188-0862	2-11:18
	SOCKET	5935-824-8977	2-11:20
C111	CAPACITOR	5910-556-1734	2-12:4
C122,C121, C120,C119, C118	CAPACITOR	5910-667-6961	2-16:4 thru 8
CR127,CR105, CR104	DIODE	5960-822-9505	2-17:41,50,55
CR102	DIODE	5960-822-9505	2-18:6
C158	CAPACITOR	5910-824-8997	2-18:7
C157,C159, C154	CAPACITOR	5910-822-8707	2-19:2, 4, 5
C163	CAPACITOR	5910-822-8691	2-19:11
	PLUG	5935-257-7799	2-21:1
	RECEPTACLE	5935-258-2983	2-21:3
	SOCKET	5935-260-0517	2-22:2
	PLUG	5935-197-3989	2-22:3

FEDERAL STOCK NUMBERS

PART NO.	PART NAME	FEDERAL STOCK NO.	FIGURE AND INDEX NOS.
	RECEIVER		
	KNOB	5355-284-5514	2-24:7
	KNOB	5355-284-5514	2-24:8, 14, 16, 20
	KNOB	5355-049-8572	2-24:9, 10, 13, 17, 18
	POST	5940-615-2282	2-25:4
	POST	5940-688-2770	2-26:2
	CONNECTOR	5935-697-3479	2-28:1
I1	LAMP	6240-770-3372	2-29:1
R570	RESISTOR	5905-822-5902	2-29:2
I2	LAMP	6240-270-4286	2-29:3
R546,S401	RESISTOR	5905-837-7934	2-29:4
R453	RESISTOR	5905-824-7911	2-29:6
R550	RESISTOR	5905-822-5919	2-29:7
S403	SWITCH	5930-754-8437	2-29:9
R405,R406	RESISTOR	5905-822-5913	2-29:10, 14
S404	SWITCH	5930-258-9732	2-29:11
S408	SWITCH	5930-636-0487	2-29:12
S407	SWITCH	5930-756-0285	2-29:15
S406	SWITCH	5930-756-0281	2-29:16
R465	RESISTOR	5905-822-5922	2-29:17
S410	SWITCH	5930-754-8438	2-33:3
	SHIELD	5960-264-3004	2-33:4, 7, 10, 12, 14, 17, 19, 21, 23, 25, 27, 29, 36, 38
V4,V14,V5, V13,V12, V11,V10, V8,V9	ELECTRON TUBE	5960-834-7504	2-33:5, 15, 22, 24, 26, 28, 30, 37, 39
V3,V7,V6	ELECTRON TUBE	5960-553-3520	2-33:8, 18, 20
V2,V1	ELECTRON TUBE	5960-262-0218	2-33:11, 13
	RELAY	5945-615-1302	2-33:32

FEDERAL STOCK NUMBERS

PART NO.	PART NAME	FEDERAL STOCK NO.	FIGURE AND INDEX NOS.
	RECEIVER		
R436, R480	RESISTOR	5905-822-0675	2-33:33, 41
R485	RESISTOR	5905-822-5902	2-33:40
R434	RESISTOR	5905-822-5916	2-33:42
R467	RESISTOR	5905-822-0676	2-33:43
	RELAY	5945-440-2572	2-33:44
R595, R596, R597, R604, R603, R602	RESISTOR	5905-822-0675	2-35:1, 3, 5, 25, 27, 30
R598, R599, R600, R601, R608, R607, R606, R605	RESISTOR	5905-822-5917	2-35:7, 10, 12, 15, 17, 19, 21, 23
CR418, CR417	DIODE	5960-822-9505	2-36:29, 32
CR407, CR408, CR409, CR406, CR419, CR401, CR402	DIODE	5960-822-9505	2-37:8, 12, 24, 30, 36, 39, 46
CR416, CR414, CR415, CR413, CR411, CR412	DIODE	5960-822-9505	2-38:12, 18, 21, 34, 39, 42
C433	CAPACITOR	5910-822-8707	2-39:1
C408, C437	CAPACITOR	5910-667-6961	2-39:2, 12
C442	CAPACITOR	5910-822-8691	2-39:5
C440	CAPACITOR	5910-669-1510	2-39:14
C432	CAPACITOR	5910-824-8997	2-40:13
	ELECTRON TUBE	5960-188-0862	2-42:1
CR405, CR404, CR403	DIODE	5960-822-9505	2-42:6, 10, 13
C441	CAPACITOR	5910-556-1734	2-42:7
	SOCKET	5935-824-8977	2-42:15

FEDERAL STOCK NUMBERS

PART NO.	PART NAME	FEDERAL STOCK NO.	FIGURE AND INDEX NOS.
	TEL-A-SCAN		
	GRATICLE	6625-799-2670	2-44:2
A	KNOB	5355-284-5514	2-44:6,7,13,18, 20,25
C	KNOB	5355-049-8572	2-44:8 thru 11,22 23
J701, J702, J703, J704	CONNECTOR	5935-826-6401	2-44:12,14,19,21
E	KNOB	5355-824-7833	2-44:15
D	KNOB	5355-824-8986	2-44:16
B	KNOB	5355-284-5514	2-44:24
	CONNECTOR	5935-697-3479	2-46:2
R824	RESISTOR	5905-837-7943	2-48:5
R826, R751	RESISTOR	5905-822-5911	2-48:6, 12
S753	SWITCH	5930-756-0267	2-48:7
S755	SWITCH	5930-756-0266	2-48:8
S752	SWITCH	5930-756-0261	2-48:9
R744	RESISTOR	5905-822-5918	2-48:13
S751	SWITCH	5930-827-5727	2-48:14
R815	RESISTOR	5905-827-9977	2-48:15
R716	RESISTOR	5905-822-5912	2-48:16
S750	SWITCH	5930-756-0268	2-48:17
R779	RESISTOR	5905-822-5913	2-48:20
C731	CAPACITOR	5910-821-9284	2-49:5
C728	CAPACITOR	5910-821-5257	2-49:12
C732	CAPACITOR	5910-821-4521	2-49:13
C729	CAPACITOR	5910-815-8386	2-49:14
C706	CAPACITOR	5910-824-8997	2-51:5
C703, C705, C715, C707	CAPACITOR	5910-815-8386	2-51:10,12,13,14

FEDERAL STOCK NUMBERS

PART NO.	PART NAME	FEDERAL STOCK NO.	FIGURE AND INDEX NOS.
	TEL-A-SCAN		
C712	CAPACITOR	5910-824-8997	2-52:5
C709, C711, C713, C716	CAPACITOR	5910-815-8386	2-52:10, 12, 13, 14
R786	RESISTOR	5905-822-5906	2-53:4
R818	RESISTOR	5905-822-5917	2-53:5
V7, V11, V12	ELECTRON TUBE	5960-248-3086	2-53:14, 25, 33
C702	CAPACITOR	5910-578-1266	2-53:16
	SHIELD	5960-264-3004	2-53:19, 20
V6	ELECTRON TUBE	5960-262-0218	2-53:20
V10	ELECTRON TUBE	5960-188-3602	2-53:21
V8, V15, V9, V16	ELECTRON TUBE	5960-834-7504	2-53:22, 23, 24, 26
V13	ELECTRON TUBE	5960-556-1328	2-53:27
V14	ELECTRON TUBE	5960-188-3544	2-53:28
L709, L710	COIL ASSEMBLY	5950-755-9029	2-53:29, 30
V17	ELECTRON TUBE	5960-166-7648	2-53:32
R823	RESISTOR	5905-822-5902	2-53:34
R776	RESISTOR	5905-827-7783	2-53:35
R805	RESISTOR	5905-822-5907	2-53:36
C764	CAPACITOR	5910-822-8691	2-54:4
C742	CAPACITOR	5910-583-0316	2-54:7, 14
	ELECTRON TUBE	5960-188-0862	2-54:11
	SOCKET	5935-824-3977	2-54:13
C719	CAPACITOR	5910-815-8386	2-54:16
V3, V2	ELECTRON TUBE	5960-262-0218	2-54:17, 19
RL1	RELAY	5945-615-1302	2-54:20
R759, R761	RESISTOR	5905-822-5921	2-56:7, 8
C725	CAPACITOR	5910-552-8013	2-57:10

FEDERAL STOCK NUMBERS

PART NO.	PART NAME	FEDERAL STOCK NO.	FIGURE AND INDEX NOS.
	TEL-A-SCAN		
C766	CAPACITOR	5910-824-8997	2-57:24
CR705,CR701	DIODE	5960-822-9505	2-57:30,61
C701	CAPACITOR	5910-578-1266	2-57:71
L709	COIL ASSEMBLY	5950-755-9029	2-58:23
C758	CAPACITOR	5910-552-8013	2-58:30
C760, C739	CAPACITOR	5910-583-0316	2-58:32,49
CR704	DIODE	5960-822-9505	2-58:35
CR707,CR706	DIODE	5960-822-9503	2-58:53,55
C701	CAPACITOR	5910-578-1266	2-58:60
C772	CAPACITOR	5910-822-8691	2-59:16
C768	CAPACITOR	5910-822-8707	2-59:17
C738	CAPACITOR	5910-583-0316	2-59:22
C733	CAPACITOR	5910-821-4526	2-60:5
C740	CAPACITOR	5910-552-8013	2-60:6
CR703	DIODE	5960-822-9505	2-60:8
C741	CAPACITOR	5910-822-8707	2-60:11
C735	CAPACITOR	5910-583-0316	2-60:12
C762	CAPACITOR	5910-822-8691	2-60:15

FEDERAL STOCK NUMBERS

PART NO.	PART NAME	FEDERAL STOCK NO.	FIGURE AND INDEX NOS.
	RACK MOUNT POWER SUPPLY		
J12,J11,J10	CONNECTOR	5935-201-2355	2-61:2,4,5
	RETAINER	5960-273-2451	2-64:1
V1	ELECTRON TUBE	5960-615-5529	2-64:2
V2	ELECTRON TUBE	5960-556-1328	2-64:12
V4	ELECTRON TUBE	5960-166-7648	2-64:14
V3	ELECTRON TUBE	5960-193-5136	2-64:19
	FUSEHOLDER	5920-248-8898	2-65:2
F2,F3	FUSE	5920-503-2886	2-65:4,11
F5	FUSE	5920-142-4837	2-65:9
F4	FUSE	5920-578-2511	2-65:10
CR3,CR6,CR5 CR2,CR4	DIODE	5960-822-9504	2-66:5,14,15,16,17
CR1	DIODE	5960-822-9505	2-66:12
CR9,CR11, CR8,CR10	DIODE	5960-822-9504	2-67:7,9,11,13
XV1	SOCKET	5935-260-0517	2-68:10

FEDERAL STOCK NUMBERS

PART NO.	PART NAME	FEDERAL STOCK NO.	FIGURE AND INDEX NOS.
	PORTABLE POWER SUPPLY		
J1	CONNECTOR	5935-201-2355	2-71:12
	RETAINER	5960-273-2451	2-73:1
	SHIELD	5960-553-4069	2-73:2
V2	ELECTRON TUBE	5960-821-5016	2-73:3
	SHIELD	5960-295-7652	2-73:4
V3	ELECTRON TUBE	5960-557-6883	2-73:5
L1	REACTOR	5950-755-9052	2-73:7
R19	RESISTOR	5905-665-5840	2-73:8
L2	REACTOR	5950-755-9051	2-73:9
R8	RESISTOR	5905-822-5904	2-74:1
F3	FUSE	5920-142-4837	2-74:2
XF3,XF2, XF1	FUSEHOLDER	5920-248-8898	2-74:3,5,6
F2	FUSE	5920-043-2641	2-74:4
F1	FUSE	5920-284-5707	2-74:7
V1	ELECTRON TUBE	5960-615-5529	2-74:8
T1	TRANSFORMER	5950-755-9045	2-74:10
C11,C3,C8, C9	CAPACITOR	5910-824-8999	2-76:2,4,5,6
CR9,CR6, CR5,CR10, CR2,CR1, CR7,CR8	DIODE	5960-822-9504	2-79:2,6,7,9,10, 12,14,16
C1	CAPACITOR	5910-811-7569	2-80:1
CR11,CR4, CR3	DIODE	5960-822-9504	2-80:3,5,6